UNWIRED

SUPPLEMENT TO WIRED

Get Wireless!

EVERYTHING YOU NEED TO KNOW ABOUT THE WI-FI REVOLUTION

10 People to Watch

Build Your Own Network in 6 Easy Steps

The 5 Next Big Things

PLUS:

How Wi-Fi is Changing the Way We Work & Live

The Complete Guide to the Best Gadgets & Services

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Unwire the big idea.

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IBM ThinkPad X31

See opposite page for warranty information.

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- Microsoft® Windows® XP Home Edition[3]
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[7]These model numbers achieved eTesting Labs, Inc.'s BatteryMark™ 4.0.1 or the Ziff Davis Media, Inc.'s Business Winstone® 2002 BatteryMark™ Version 1.0, Battery Rundown Time of at least the time shown. This test was performed without independent verification by the VeriTest testing division of Lionbridge Technologies, Inc. ("VeriTest") or Ziff Davis Media, Inc.; neither Ziff Davis Media, Inc. nor VeriTest makes any representations or warranties as to these test results. Winstone is a registered trademark and BatteryMark is a trademark of Ziff Davis Publishing Holdings, Inc., in the U.S. and other countries. A description of the environment under which the test was performed is available at *ibm.com/pc/ww/thinkpad/batterylife* Battery life (and recharge times) will vary based on many factors including screen brightness, applications, features, power management, battery conditioning and other customer preferences. 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MOBILE TECHNOLOGY

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from the editors

WI-FI is here. **NOT SINCE** the birth of the Web has a new technology offered so much possibility. The past decade has seen a growing fascination with all things wireless, from mobile phones to two-way pagers to GPS handhelds. Now Wi-Fi is unwiring the Internet itself, linking our gadgets and changing how we communicate with each other, entertain ourselves, and use our public spaces. Best of all, the Wi-Fi revolution has been organic, up from the grassroots and unfettered by government regulation.

WIRED is committed to making sense of a fast-changing world, and we've covered wireless innovation all along. Today, as Wi-Fi pushes further into the mainstream, we offer the ultimate user's guide. So what to call it? In a recent issue, the legendary Arthur C. Clarke suggested it was high time we listen to the technology and change our name to *Unwired*. For one issue we'll give it a try.

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CONTENTS

6 Wi-Fi Revolution
The wireless Internet has arrived – and now the sky's the limit. **by Chris Anderson**

PLUS: 10 people to watch – innovators, rebels, and policymakers.

20 Wireless Country
A map of how we use the airwaves, from AM radio to Wi-Fi. **by Xeni Jardin**

24 How to Hook Up
Everything you need to know to build your own network – a step-by-step guide. **by Paul Boutin**

28 Power Tools
Gearing up for the wireless life: the best base stations, PC cards, Wi-Fi cams, media receivers, and more. **by Neil McManus**

38 The Way We Work
How Wi-Fi is transforming everything from farming to theme parks – four stories from the wireless frontier. **by Jessie Scanlon**

44 Good-Bye 3G – Hello Wi-Fi Frappuccino
Cellcos bet big on third-generation wireless – and took a big hit. Now T-Mobile's John Stanton has a grand convergence plan. Starbucks is just the beginning. **by Dan Briody**

48 Palm Pulls the Plugs
Free at last: A case study in learning to love the unchained corporation of tomorrow. **by Brad Stone**

52 20,000 Nodes or Bust
Everybody talks about the Wi-Fi future. Cometa CEO Larry Brilliant is building it. **by Lucas Graves**

56 Beyond Wi-Fi
The 5 next big things. **by Xeni Jardin**

58 25 Companies to Watch
A user's guide to service providers, software companies, hardware makers, and chipset manufacturers. **by Paul Boutin**

60 Fast Forward
A sneak preview.

the wi-fi revolution

BY CHRIS ANDERSON

The wireless Internet has arrived – and now the sky's the limit.

JOHN HERSEY

WE STAND AT THE BRINK

of a transformation. It is a moment that **echoes** the birth of the Internet in the mid-'70s, when the radical pioneers **of computer networking** – machines talking to each other! – hijacked the telephone system with their first **digital hellos.** Or that **jaw-dropper** a decade later when the FCC official whose job it was to track the growth of communications networks **suddenly realized** that his neat tabulation of local and long-distance had been made moot by the unforeseen rise of local-area networks: an **unregulated, unmonitored, uncontrollable** phenomenon of the upstart PC industry that would soon **shake the telecom world.** Or the arrival of the Web browser, which blew millions of minds, making a mouseclick feel like **teleportation.** ◎ This time it is **not wires but the air** between them that is being transformed. Over the past three years, a wireless technology has arrived...

Wi-Fi Explained

Wireless networking comes in a variety of flavors, all of them identified by a string of numbers and letters only a librarian could love. Beware: Not all standards are created equal.

802.11b

The standard that started it all. Seeking to invent a speedy way to send data via unlicensed airwaves, engineers working on a standard for wireless local-area networks borrowed from existing technologies – Ethernet's data packets, the Internet's routing protocols, and spread spectrum's use of many channels within a frequency band. The result is information delivered at speeds up to 11 Mbps in the 2.4-GHz band, and at a range of about 300 feet. In 1999, an industry group wisely decided to give it a more friendly name and settled on the retro-chic Wi-Fi, for wireless fidelity.

802.11a

Finalized four years ago, 802.11a works in the 5- to 6-GHz band at speeds of up to 54 Mbps. Products based on the standard were first introduced in late 2001. Its strengths: high speed and lower risk of radio frequency interference than either 802.11b or 802.11g. Its weakness: *a* is incompatible with the more popular *b* and the emerging *g*, because it strayed from the 2.4-GHz band. As a result, some manufacturers have quit building products for it. But as WLANs proliferate, it could prove essential to serving large populations in concentrated area, such as downtowns, universities, and business centers.

802.11g

The much-anticipated 802.11g has already been revised six times; approval is expected in mid-2003. Why all the excitement? It promises complete interoperability with *b* and transmission rates up to five times faster in the same 2.4-GHz band. Early products are already on the market from Wi-Fi heavyweights such as Apple, Linksys, Netgear, and D-Link. Among the challenges for *g*: higher vulnerability to radio frequency interference from other 2.4-GHz devices, such as late-generation cordless phones.

with the power to totally change the game. It's a way to give the Internet wing without licenses, permission, or even fees. In a world where we've been conditioned to wait for cell phone carriers to bring us the future, this anarchy of the airwaves is as liberating as the first PCs – a street-level uprising with the power to change everything.

The technology is Wi-Fi, and it's the first blast in a revolution, called open spectrum, that will drive the Internet to the next stage in its colonization of the globe. Like the Net itself, Wi-Fi was confined to technical circles for years before exploding into the mainstream, seemingly out of nowhere. Over the past two years, it's become one of the fastest-growing electronics technologies in history.

What makes the new standard so alluring? Wi-Fi is cheap, powerful, and, most important, it works. A box the size of a paperback, and costing no more than dinner for two, magically distributes broadband Internet to an area the size of a football field. A card no larger than a matchbook receives it. The next laptop you buy will probably have Wi-Fi built in. Wires may soon be for power alone.

But the appeal goes deeper. Wi-Fi represents a fundamentally different approach to the airwaves that could lead to a new era of wireless policy. Like other open spectrum technologies rising in its wake, Wi-Fi is a way to use the handful of frequencies set aside for unrestricted consumer use. That's true of the old CB radio, too, but unlike the trucker channels Wi-Fi is digital and smart enough to avoid congestion. After 100 years of regulations that assumed serious wireless technologies were fragile and in need of protection by monopolies on exclusive frequencies (making spectrum the most valuable commodity of the information age), Wi-Fi is fully capable of protecting itself. It has turned the airwaves into a commons without tragedy, and turned the economics of wireless on its head.

Among the geeks, Wi-Fi has become a fascination, a glimpse of the future of the Internet. Like the Web, it's open, unregulated, and free. It doesn't require a loyalty oath to some corporate behemoth. Anyone can deploy it, and millions have. For many it's an epiphany – the unforgettable impact of being in the presence of something important and new.

No one has been more startled by all of this than the big cellular companies, which paid dearly for transmission rights just a few years ago. Flush with the success of digital phones, they expected the next big thing to emerge the same way. US firms were focused on catching up with their European rivals, who in turn were obsessed with the prospect of ruling the next great technology era (take that, Silicon Valley!) with so-called 3G networks, which would offer multimedia

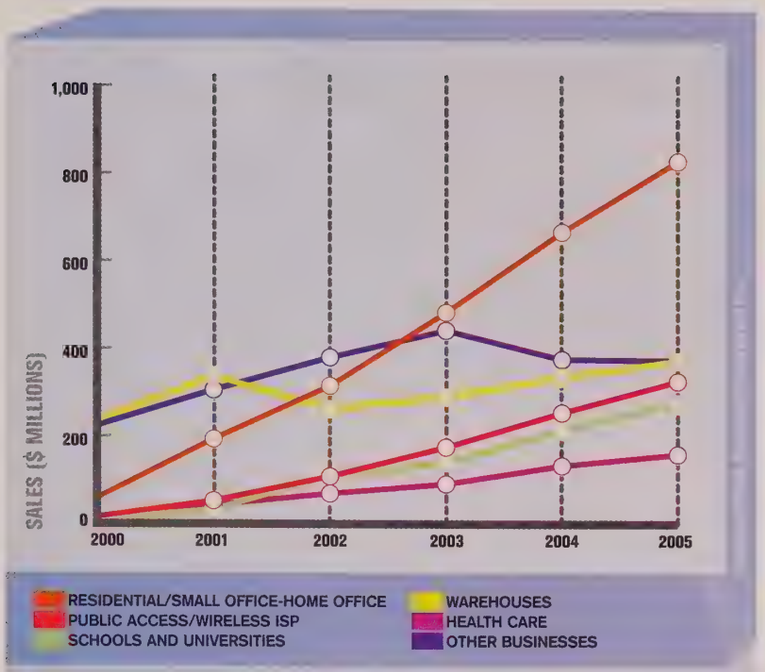
People to Watch

Introducing the innovators, rebels, and policymakers who are leading the wireless revolution.

Anthony Townsend and Terry Schmidt — the pirates

The most famous Wi-Fi node in the world, in midtown Manhattan's Bryant Park, went live last June, switched on by Anthony Townsend, who teaches urban planning at NYU, and his free-wireless comrade, Terry Schmidt. By the end of the summer, the network was drawing 50-plus users a day and had transformed the duo's organization, NYCwireless, from a bunch of bandwidth pirates into a respected champion of public access. Their pitch: Any neighborhood can go wireless, for as little as $1,000. "Bryant Park spends almost as much on rat poison every year," says Schmidt. The two are now at work on a new, eight-node "walking network" that will put every part of downtown within a five-minute walk of free Wi-Fi. – Lucas Graves

ILLUSTRATION BASED ON PHOTOGRAPH BY RICHARD BALLARD



The Growth of Wi-Fi at Work and Home

Wi-Fi first took off in companies and for industrial uses, but then became a consumer hit. The home market will exceed all others this year.

Top 10 Unwired Cities

Looking for a Wi-Fi hookup? Based on the number of access points in business districts, airports, and parks, we ranked the most Wi-Fi friendly US cities.

	CITY	COOL HOT SPOT
1	San Francisco	Levi Strauss Plaza
2	New York	Bryant Park
3	Seattle	Any of 77 Starbucks
4	Chicago	O'Hare airport
5	Atlanta	Four Seasons
6	Los Angeles	Downtown Long Beach
7	Dallas	Crossroads Market Bookstore & Café
8	Washington, DC	Tryst Coffeehouse and Bar
9	Twin Cities	Mall of America
10	San Jose	San Jose International Airport

on a new generation of do-everything smartphones. But the 3G dream was already in trouble. The technology wasn't working well, and amid the telecom bust, the $100 billion European carriers borrowed for spectrum licenses was starting to seem like a colossal mistake.

Then came a bolt out of the ether: Consumers realized there was a way to get wireless Internet that didn't require phone companies at all. Wi-Fi had arrived, and it did what it promised right out of the box. Cheap Wi-Fi packages started showing up on the shelves of Wal-Mart and Best Buy, and they sold in remarkable numbers: 12 million units last year, and on pace to double that this year.

What's extraordinary about this boom is that it's an authentic grassroots phenomenon, happening in the home even faster than in the office. Companies are cautious about the security implications of a network that goes through walls and into the street, but most home users are too dazzled to care. Anyone with a broadband connection can plug a $100 access point into a cable modem or DSL box, slip a $60 card into a laptop, and suddenly have that most fabled of tech ambitions: Internet everywhere, or at least everywhere around the house. Stream video from the couch, surf in bed, email in the backyard, all at lightning speed. How many other technologies leave even hardened gadget vets grinning with amazement?

And that's just the beginning. We are starting to see the next phase of the Wi-Fi movement: the rise of public networks. Already there are thousands of open-access hot spots across the country, everywhere from Starbucks and airports to city parks. Others are ad hoc community nets, such as neighboring apartment dwellers using Wi-Fi to share a broadband connection. Tens of thousands more are accidental, leaking out of private homes or offices and often free for passersby to hitchhike on. With prices for Wi-Fi equipment continuing to plummet, it's just a matter of time before the scattering of Wi-Fi dots on city maps grow dense and then overlap.

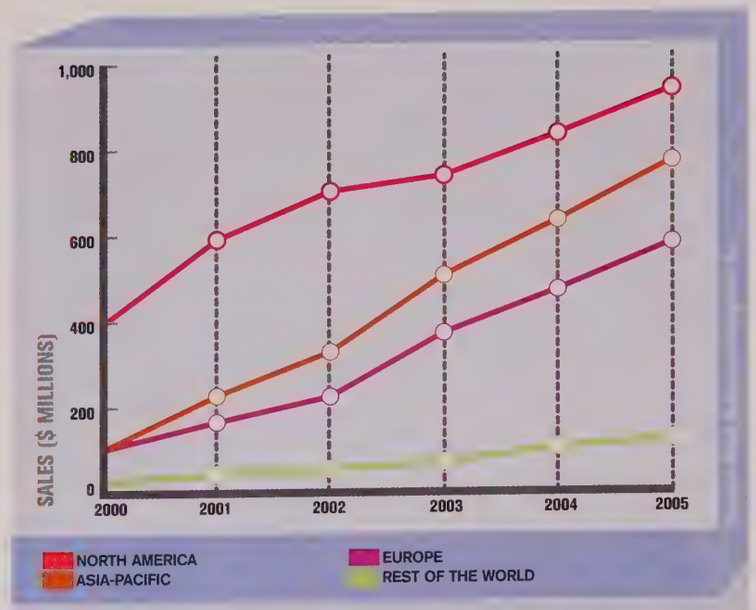
In the years ahead, Wi-Fi will become a universal standard, found everywhere in the electronics world. It will show up in consumer electronics devices, from videogame consoles to music players. Cell phones will have it, as will PDAs and digital cameras. Any PC bought in a year or so will instantly become the hub of a wireless network, simply by turning it on. The numbers will quickly reach true mass-market levels: an estimated 99 million people with Wi-Fi by 2006, according to Gartner.

All of this amounts to an inversion of the usual adoption cycle, where big companies must build communications infrastructures

Sky Dayton — the surfer

PEOPLE TO WATCH

If it worked once, Sky Dayton figures, it could work again. So he modeled his new Boingo Wireless on EarthLink, the Internet service provider he founded in 1994: String together hundreds of local access providers into a seamless network, then share the revenue. A year in, Boingo claims to have about 1,200 Wi-Fi hot spots in 300 cities throughout 46 states. Boasts Dayton, "We're the first company to make it easy for anyone to find and connect to a huge network of hot spots." Nipping at his heels: Cometa Networks, a joint venture of AT&T, Intel, and IBM; AT&T Wireless, a partnership with wireless ISP Wayport; and fast-growing Wi-Fi service providers. – Mark Frauenfelder



The Growth of Wi-Fi Around the World

North America, where most of the big Wi-Fi makers are based, leads the market today. But in Asia Wi-Fi often represents the first broadband technology deployed, rather than a replacement for something else, and as a result it is rising fast.

fast fact

[illegible] of hot spots around the world increased tenfold to 12,000 in the past year.

to encourage consumers to jump on new technologies (as was the case with cell phones). Wi-Fi is becoming ubiquitous for its own reasons. The question is, what networks and services will arise to capitalize on it? Rather than "build it and they will come," the mantra is "they're already here, now build it!"

But build what, exactly? Here are the next four big fronts in the Wi-Fi invasion.

Making it work everywhere. Today the gap between a cell phone experience and Wi-Fi is huge. With a phone, it's usually safe to assume you've got a signal; with Wi-Fi it's almost always safe to assume you don't. Even in the presence of a hot spot (and there are few good ways to know you are, short of opening your laptop and "sniffing" for it), odds are you won't be able to log on, because it's either a private network or a commercial one that requires a subscription. Even places that advertise access, such as hotels and airports, often have it just in the lobby or at certain gates.

Several companies are working on key chains, cards, and pendants that will glow in the presence of a Wi-Fi signal, which is a start (especially if they are smart enough to identify only the networks you can log on to). Cell phones could do the same. But until commercial hot spots are widespread and roaming agreements are in place between them, public Wi-Fi will continue to be more like the Internet café experience, where you have to seek out access, than the cell phone experience, where it finds you. Companies such as Boingo and Cometa are aiming to achieve this, but it's a big world out there. Expect a few more years of frustration.

Unwiring the living room. Digital media, from MP3 to DVD, is taking over, but the equipment in most homes is still largely analog. Consumer electronics makers have been unable to come up with a common digital standard to link gear, and even if they did, few consumers want to string networking cable under their couch.

Wi-Fi can break this logjam and become the common link that ties together music, video, and even phones around the house, automatically and effortlessly. Then the notion of a central entertainment server, which records TV, stores music and video, and plays it back on any screen in the house, will finally take off. Once the living room is a wirelessly networked digital media hub, the long-awaited era of Internet video may arrive, kicking broadband demand into high gear.

Using Wi-Fi to cross the last mile. As consumer electronics start to ship with wireless networking built in, demand will skyrocket for the broadband connections to make it all worthwhile. Which could be another opportunity for Wi-Fi. Currently, getting broadband at

Teresa Meng

the professor

PEOPLE TO WATCH

Five years ago, Stanford electrical engineering professor Teresa Meng founded Atheros to produce her groundbreaking Radio-on-a-Chip – a marvel of integration and miniaturization that cornered the market on 802.11a wireless equipment. But as demand rose for the earlier standard, 802.11b, Atheros created a single, low-cost chipset that worked with both standards, as well as the emerging 802.11g. Now the company's improving output power to extend the chip's range. Meanwhile, Meng continues her prize-winning research in low-power circuit design, wireless communication, and biosignal processing. "Five or ten years from now, we won't worry about communication with wires," she says. "You'll just open your laptop or PDA and the data will be there!" – Joseph Portera

TOP: KENN BROWN; BOTTOM: ILLUSTRATION BASED ON PHOTOGRAPH BY JAMES COLEMAN

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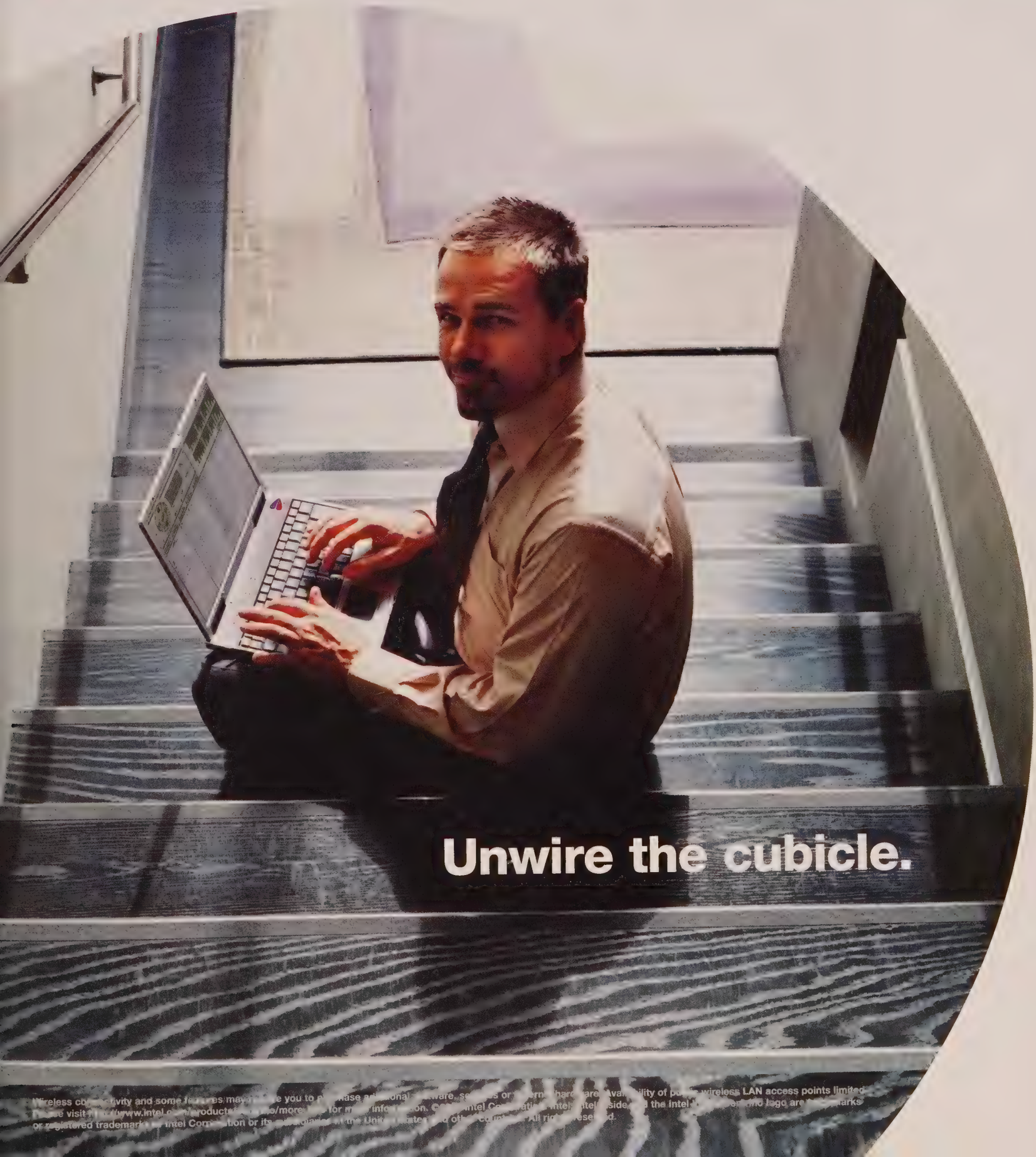

Wireless connectivity and some features may require you to purchase additional software, services or external hardware. Availability of public wireless LAN access points limited. Please visit http://www.intel.com/products/centrino/more.htm for more information. Copyright © Intel Corporation. Intel, Intel Inside, and the Intel logo are trademarks or registered trademarks of Intel Corporation or its subsidiaries in the United States and other countries. All rights reserved.

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Free the Air!

AS BIG AS IT IS, Wi-Fi is just the start of something even bigger: a set of "open spectrum" technologies that could rewrite the rules of the airwaves, reversing a century of regulatory policy and enabling an explosion of new wireless devices and services.

The notion that wireless users, like airplanes in a landing pattern, need to be fenced off by themselves is an anachronism, a throwback to the days of analog. Radio signals are not like physical objects, which cannot occupy the same space at the same time without a crunch. Electromagnetic waves pass through one another effortlessly, and they can be extracted from a sea of other signals, even on the same frequency bands. The trick is knowing what you're looking for.

Two technologies have made that easier. The first is spread spectrum, which is a way of scattering a transmission around over many narrow frequencies, shotgun-style. Even if some are drowned out by interference, others will still get through – noise is rarely evenly distributed. And because the receiver knows the sequence of frequencies that the transmissions will be coming in, it can ignore those arriving at different times.

The second is digital radio, which can break up a transmission into Internet-like packets with addresses. DR receivers pay attention only to the packets meant for them, allowing many devices to use the same frequencies. Add error correction and the ability to resend any part of a message that is lost, and you have radios that can cut through the noisiest environments and share airwaves with hundreds of nearby transmitters.

On the back of the Wi-Fi phenomenon, a growing cadre of open spectrum activists are now pushing for wholesale changes in telecom regulation, extending the same principles to the rest of the wireless world. How much lower would your cell phone bill be if carriers didn't spend billions for licenses? How much closer would you be to broadband Internet in your pocket? The only thing that has kept the venerable landline alive for so long is the assumption that the airwaves were too limited to be shared by all. Once we thought the same about the Internet itself. – **C.A.**

Open spectrum technologies cut through the noise rather than requiring regulatory protection from interference. One key technique is spread spectrum, a way to transmit over many frequencies simultaneously; if some channels are blocked, others will let data through. Wi-Fi spreads its signal over 14 channels on the 2.4-GHz band.

Ken Biba

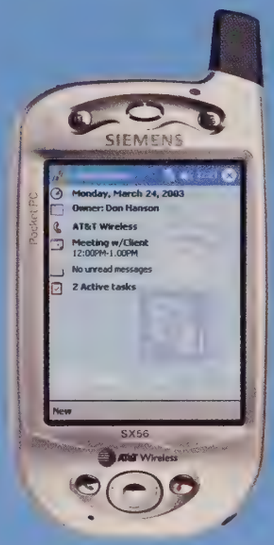
the distance runner

PEOPLE TO WATCH

Ken Biba helped develop TCP, the connection protocol at the heart of the Internet. Now, as CEO of Vivato, he's again at the center of a revolution. So far, Wi-Fi has been confined to local networks. Because its limited range means you'd need up to 2,000 nodes to cover, say, a university campus. But Vivato's switching technology – the first in the industry – extends reach from roughly 30 feet to 4 miles. You'd need just 30 to 50 Vivato switches to turn all of Dartmouth into a hot spot. And it may go further than that. "Data can't travel on a voice network, but voice can travel on a data network," says Biba. Watch out, Grandma Bells. – Jessie Scanlon

ILLUSTRATION BASED ON PHOTOGRAPH BY JAMES COLEMAN

IF THERE IS A HIGHER ORDER OF SPECIES, THIS IS HOW THEY COMMUNICATE.



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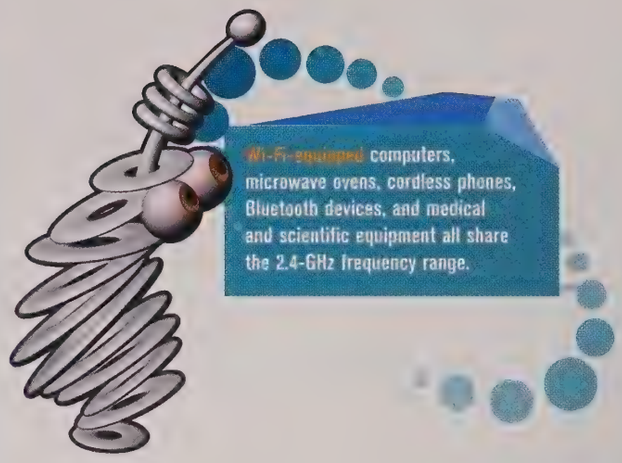
The Rise of Multiband 802.11

802.11b, the most popular Wi-Fi standard today, has peaked, while 802.11g is on the rise. Both will eventually be passed by multiband devices.



home is, at best, an uninspiring choice between the phone company and the cable company – if it's available at all.

Wi-Fi hot spots mounted on lampposts or telephone poles, with directional antennas to extend their range and avoid congestion, could offer as good or better service. And the economies of scale of a truly mainstream technology could make it far cheaper than other wireless options. Also, neighborhood Wi-Fi "umbrellas" could employ the miles of unused fiber-optic cable that are a legacy of the telecom bubble, effectively bridging the otherwise expensive "last mile" from the main telecom networks to individual homes.

Converging with the cell phone. Finally, once there's widespread Wi-Fi in the home, the neighborhood, and enough public spaces, wireless convergence starts to make sense. Today, it's not uncommon to find consumers who are fully wireless: a cell phone outside the home, cordless phones within, and a Wi-Fi network for data. Yet, while some of these devices share the same frequencies (cordless phones and Wi-Fi both use the 2.4-GHz and 5-GHz bands), they are based on different standards and can't talk to each other.

Bringing them together is just a matter of time. Wi-Fi, especially in higher-speed incarnations, is as capable of transmitting voice as any cordless phone, and because calls travel over the Internet rather than over a phone network, they are far cheaper. By the same token, several companies are planning to add Wi-Fi to cell phones, allowing users to make calls over the Internet when in Wi-Fi range. The dream to emerge from this is a single device that moves seamlessly from home to road, using the best network available wherever it is.

It's this vision of convergence that has the smarter telcos reconsidering their 3G plans in light of the Wi-Fi boom. There are many parts that still must come together, but it is not hard to imagine a day when the Internet really is everywhere, just in different strengths and price tiers depending on the cost of the underlying infrastructure. Your phone might be free to use at home and in the office, cheap in your neighborhood and downtown, free again at a café trying to boost business, and relatively expensive on the highway. Most of those would be Wi-Fi networks, with cell phone service as a seamless but costly fallback, like analog roaming is for digital phones today.

Wi-Fi is just a few years old – still in its first blush of success. No doubt some of the above will prove impractical, and problems from security to interference will arise to slow its growth. But it has already proven gloriously disruptive, as all great technologies are. Will it shake the cell phone industry? We don't yet know. But the golden age of wireless has only just begun. Give it time. ■ ■ ■

Michael Powell

the man

PEOPLE TO WATCH

If you're a regulator who doesn't like to regulate, it doesn't get any better than Wi-Fi. To FCC chief Michael Powell, the use of unlicensed spectrum for free-floating Internet access is "a demonstration of the wonderful unintended consequences of less government intrusion." Now the commission is looking at unused television spectrum: If there's no Channel 7 in Cincinnati, why not free up the bandwidth? Broadcasters may balk, but Powell thinks everyone would benefit eventually. Meanwhile, he's set up hot spots in the FCC itself. "We're not quite Starbucks," he quips, "but it's still pretty neat." – Frank Rose

ILLUSTRATION BASED ON PHOTOGRAPH BY CORBIS

wave > wire

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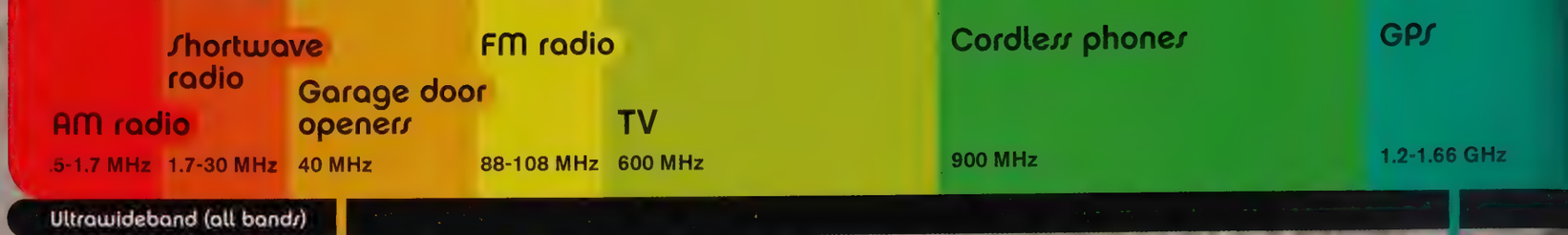
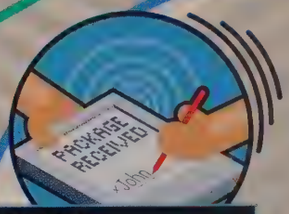


Garage door openers
It's not just transmitters in the car; some garage doors have wireless keypads.

wireless country

BY
KENI JARDIN
ILLUSTRATION BY XPLANE

Every day and everywhere, we are surrounded by the radio chatter of intelligent machines. Wireless connected the world a century ago, and it is doing it again, in ways Marconi could never have imagined – man to message, device to device, Earth to space and back again. Here, a selected guide to life unplugged.



UPS tablets
The driver logs a signature and upon return relays it to a server as proof of delivery.

Kitchen convergence
Load dinner in the smart microwave in the morning, then email it instructions when it's time to cook. (In the meantime, it keeps food cool.)

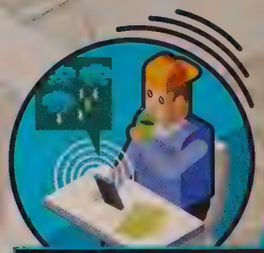
Vehicle loggers
Can't find your car? A remote manager is alerted – and GPS helps find it.

Pet training devices
Fido wears a device that administers a mild electric jolt when he strays out-of-bounds or misbehaves.

GPS telematics
Drivers can get help with navigation and traffic conditions.

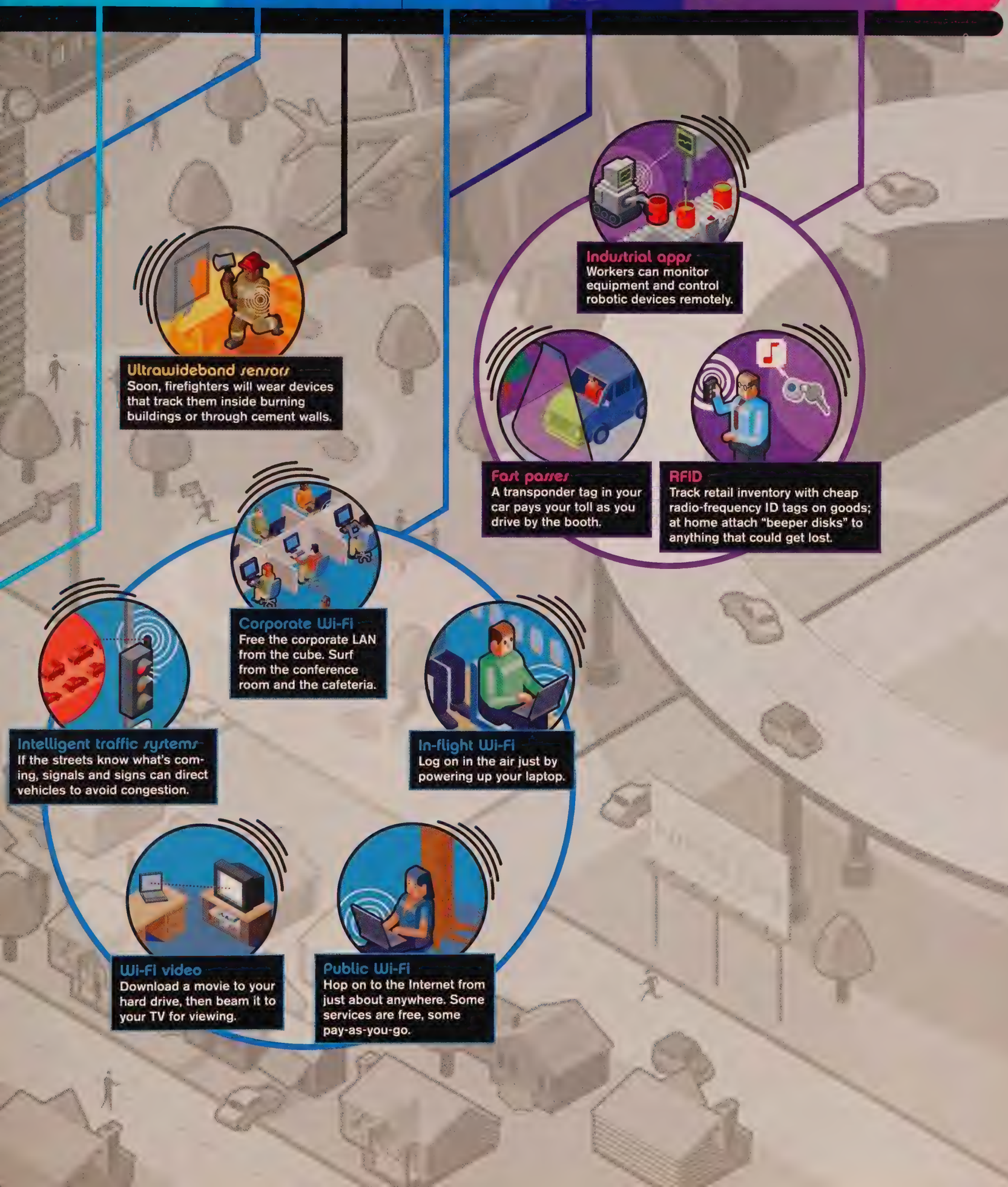
Cell phones
Can you hear me now? Good.

Mobile computing
Handheld devices with QWERTY keyboards from Handspring, Palm, and RIM offer email and Web browsing.



Mobile gaming
A new generation of wireless data networks has made cell phone gaming actually fun. Downloadable retro hits run great on Java phones.

Cell phones	Bluetooth	802.11b 802.11g	802.11a	Industrial and commercial	Satellite TV
1.8-2.1 GHz	2.4 GHz	2.4 GHz	5 GHz	5.8 GHz	12 GHz



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Notebook users with Intel® Centrino™ mobile technology can access thousands of T-Mobile HotSpots that are cleverly disguised as coffeehouses, bookstores and airline lounges.

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Try a free T-Mobile® HotSpot℠ Day Pass* and find out what a T-Mobile HotSpot can do for you. They're available right now at T-Mobile HotSpot locations such as Starbucks, American Airlines Admirals Clubs and Borders Books & Music. For further inquiries contact T-Mobile at 1-800-981-8563 or log on to t-mobile.com/hotspot.

T-Mobile HotSpot℠

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Go to: **www.intel.com** for more information about Intel® Centrino™ mobile technology.

how to hook up

BY PAUL BOUTIN

A step-by-step guide to building your own network.

GETTING STARTED

All it takes is a broadband connection, a few hundred dollars, and a willingness to pull the plugs.

1 GET A BASE STATION

When it comes to buying equipment, think a, not b. New 802.11g base stations is costing five times faster than 802.11b gear, yet it will interoperate with that as well.

If you're a PC fanatic, try the Linksys WRT54G 802.11g base. It will work on almost any net connection, and the numerous other Linux-based software upgrades. It has a built-in firewall to stop hackers from finding your hard drive location from the Internet, and a throughput jack lets you network other computers via Ethernet cable. Price should run about $150.

If you're an Apple devotee, get an AirPort Extreme, about $249. It's pricier than earlier AirPorts, but newer Macs come with the software to run it.

2 BUY A CLIENT CARD

Linksys' 802.11b card (in both backup and desktop versions) is a good deal for PCs at about $75. Try to locate more than the old cards yet will enable you to use the faster 802.11b bands.

For Apple owners, go to the Apple Store and buy whichever card is the company offers for your computer: AirPort Extreme for iBook machines, AirPort 802.11b for the iMac and One of the newer PowerBooks has the card built in, and some new Macs come with the Extreme card.

3 TURN ON THE NETWORK

Simply plug your Internet connection into the base station and install the client card in your computer or laptop. Then turn on the base and your new wireless computer. Wait as they find each other. Open a browser and try to go to a favorite site. If it works, congratulations. You've got Wi-Fi. If it doesn't, you most likely have to enter some ISP information into your base station's setup program. Check your manual.

Finally, secure your network. There's nothing more confusing than when two neighbors both have a network named "default" or "linksys." Pick something easy to remember, as users of older Windows laptops will need to enter it every time they join in.

EXTENDING RANGE

Smart placement of your gear and investment in a powerful client card will increase by a few yards the distance you can roam from your base station.

1 AVOID OBSTACLES

Usually, just moving the base from behind a wall or raising it higher off the ground will take it to each of corners of your house. Keep it away from metal tables and dense filing cabinets which can block radio waves.

Also, the signal strength of most bases and laptops isn't the same in all directions, but rather resembles along a dome that may not be pointing the right way for your needs. If your base has the usual "rubber duck" antennas, try sitting one upright up and one sideways, to cover different planes. If you have an AirPort or another unit with an internal antenna, stand it on end to see if it works any better.

If these simple steps fail, and you've got a Linksys 802.11b base, the company's $90 plug-in signal booster extends its range enough to cover most homes.

2 MOVE YOUR LAPTOP

The more powerful your Wi-Fi card, the better. Most models run at 30 to 100 milliwatts. Hot rodders go for the 200-milliwatt Enterprise Ultra Long Range card, it's the most powerful card for sale in the US — that meets FCC approval. Not only does it transmit farther, it's more sensitive to incoming signals.

As with the base, the card's antenna signal and receptions are strongest in one particular plane. You can often get a better connection by slightly tilting your laptop or facing a different direction.

3 FUTZ WITH THE ANTENNA

You've likely heard about people attaching a Pringles can to a base station or a laptop client card. And you've probably seen photos of "war-driving" teens with 3-foot antennas attached to their rooftops, looking to steal someone else's network. Let them. You can try adding a smaller external antenna for about $100, but it may provide only a 10 to 15 percent range boost indoors. Spend your money on a more powerful card instead.

XPLANE

Microsoft

During lunch, in the park, a brainstorm. It's a laptop. It's a simple pad and pen. It's a Tablet PC.

A great idea may not wait until you get back to the office, back to your desk. The Tablet PC puts the full power of Windows® XP Professional in a laptop computer that with a flip of the screen becomes as simple to use as a pad and pen. You write, draw, scribble, and erase directly on the screen. Plus it runs all of your favorite Windows XP compatible applications. And built-in wireless support means whether you're in your office or on the go, you have access to the information you need. For more information, visit microsoft.com/tabletpc

Microsoft Windows xp Tablet PC Edition

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BEING SECURE

With enough encryption, even the CIA would have trouble reading your email. But additional safeguards can slow your network. Fortunately, there are some simple things you can do to keep out all but the most determined hackers.

1 CREATE A PASSWORD

If all you want to do is keep neighbors and passersby from hogging a free ride, you can close the network. Your base station's setup menus include an option to establish a non-delicious logon password that everyone must type to connect.

To prevent anyone else from reconfiguring the base station, change its default password, too. Many base stations come with passwords like "admin" or "default," both of which are hardly original and easy to guess.

Closing your network won't prevent a dedicated hacker from breaking in or sniffing your online shopping traffic for credit card numbers, but your home network is an unlikely target. Worry more about locking the car.

2 USE ENCRYPTION

If you intend to send sensitive email and spreadsheets containing confidential data, encrypt your data traffic with the Wired Equivalent Privacy protocol. As its name suggests, it's meant to make Wi-Fi as secure to use as a network cable.

The rub: Installing it can be tedious, so it's most suitable for businesses with IT staff. WEP works much like a basic network password, but logging on may require users to type in long computer-generated, 26-character cryptographic keys — gibberish like 0x4B90CD27BA128267F2A254E5FF. Be prepared to assist visiting salespeople and other office guests.

WEP also has known security holes, so it will be phased out around the end of 2002 in favor of Wi-Fi Protected Access, a more robust encryption method with a user-friendly interface.

3 INSTALL A VPN

The most secure way to connect via Wi-Fi is a virtual private network, which creates an encrypted pipeline from your computer through your base station to an Internet gateway under guard at your ISP or company's server room. But you'll need an expert to set up and maintain this gateway. Ask your office IT staff if it has a VPN. Or if you need security for personal use, Bonus includes one in its consumer-grade service plans.

The downside: Compatibility issues may keep you from connecting to your VPN through some wireless networks. Also, help can be hard to get on the road. At those times, you'll have to surf bare — if you dare.

SHARING YOUR NETWORK

You may be super to include your neighbors and passersby. If your ISP permits sharing, remove the password from your network. Then these few extra steps will make your gift go farther.

1 TURN OFF PASSWORDS AND ENCRYPTION

Make it easy for others to get on. This will be scary for some people, but rest assured that potential freeloaders aren't interested in you. They want to use the bandwidth, not read your email.

2 INSIST ON SECURITY

If you'd like to keep a password and/or encryption on the network, set the network name to the URL of your home-page, e.g., www.paulbouth.com. Put contact info there for Wi-Fi users, who can request the password from you.

3 POSITION YOUR BASE STATION APPROPRIATELY

Remember, signal strength decreases as the distance between base station and laptop increases. Place your base as close as possible to a street, patio, or chairs where others will sit.

4 REGISTER YOUR HOT SPOT

Many Wi-Fi users go online to 802.11hotspots.com, WiFinder.com and NetStumbler.com to find hot spots, but the databases are only sparsely populated. Finding a hookup in, say, rural Maine could be tough. Submitting your network to these sites will make you a star.

TAKING IT ON THE ROAD

Finding networks is easy if you have the right tools and do your homework.

1 SNIFF WITH SOFTWARE

Windows XP and Apple's Mac OS X automatically build and update lists of available networks. But you'll get a lot more information by downloading software from NetStumbler.com, or its Apple counterpart MacStumbler.com. These free programs tell you not just the names of available networks but how strong their signals are and whether they have encryption turned on.

2 SNIFF WITH HARDWARE

If you're wary of whipping out your precious laptop in strange places, carry iGreen's WF-01 Wi-Fi Sniffer, a credit card-sized probe device with LEDs that light up in the presence of a network. It's also good for walking around the room to find the strongest signal point before you settle down to work.

3 DON'T TAKE NO FOR AN ANSWER

Still in hotels, coffee shops, and offices are often unaware there's a base station hidden right behind them. Double-check for yourself by touring the room with NetStumbler software or Wi-Fi Sniffer. If you can't find a signal in a hotel you know is networked, change rooms or get closer to a base.

4 DARE TO LOOK STUPID

Just like a cell phone, your wireless notebook is a radio with a built-in antenna. If you need to find and a weak signal, a little body movement can get you online while others are pounding their keyboards in frustration. Sure, slowly in circles, raise your laptop up and down, hold it above your head like the Tin Commandments – hey, it beats taking a cab back to the hotel.

5 STOP AND SMELL THE COFFEE

Find a Starbucks, where you can get T-Mobile service – 2,000 hot spots and counting. The cost: a $6-per-hour charge to your credit card.

MAKING MONEY

If you're hoping to get rich off your home network, forget it. But if luring business travelers through your door is how you make a living, Wi-Fi can bring in extra customers and keep them there. They may even pay for the privilege.

1 ADVERTISE

Most businesses hide their base station in the back room. Why not set it out front in plain sight, with a clearly visible sign? Internet access may be just what shoppers nothing post are looking for.

2 GIVE IT AWAY

If you're a retailer looking to maximize foot traffic, take the simplest route: Set up an open network with no password, so anyone who walks in can get online instantly without your staff's help. Once they're focused on and settled down, they're yours.

3 OUTSOURCE

If you're bent on charging for Wi-Fi, hire somebody to run the operation. Boingo offers a plug-and-play solution for small businesses, while Surf and Sip may even come in and set up the system. These companies handle sign-ups, tech support, and billing, then send you a cut of the monthly take.

power tools

BY NEIL McMANUS

Gearing up for the wireless life

54G ROUTERS

The future of Wi-Fi is 802.11g, five times faster and backward-compatible with 802.11b, the current standard. Caveats: Web surfing – bottlenecked by your Internet connection, not these routers – will seem as slow as ever, and the first batch of products will need upgrades once g gets ratified later this year. That said, gimme-gimme folks already have a raft of zippy routers to choose from.

APPLE AIRPORT EXTREME BASE STATION
$199
www.apple.com

D-LINK AIRPLUS XTREME G DI-624 WIRELESS ROUTER
$149
www.dlink.com

LINKSYS WIRELESS-G ROUTER
$199
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BELKIN 54G WIRELESS CABLE/DSL GATEWAY ROUTER
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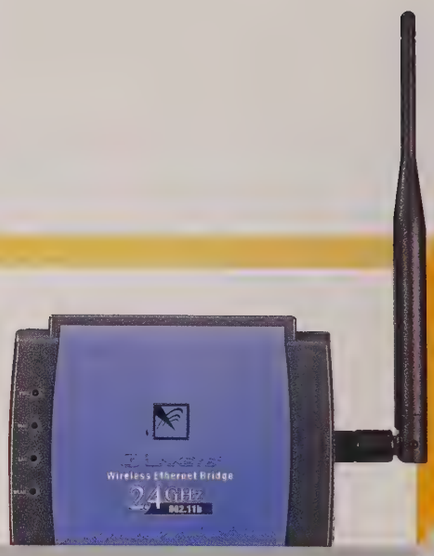

One of the joys of online gaming is crushing opponents across the globe. Meanwhile, your Ethernet cable won't even let you across the room. Break loose with this bridge, which turns an Ethernet port into a Wi-Fi connection, making nearly any device – Xbox, PlayStation 2, laser printer, older PC – wireless ready.

LINKSYS WET11 WIRELESS ETHERNET BRIDGE
$119
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POCKET PCS

The days of handhelds as glorified tip calculators are gone. The latest Pocket PCs are do-it-all marvels. The HP iPAQ h5455, for example, doesn't miss a bell or a whistle. Wi-Fi? Yep. Bluetooth? Roger. Biometric fingerprint reader? Sure, what they heck. Check your email when you're out and about. This pumped-up device can connect to the Net through a mobile phone or Wi-Fi hot spot.

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$699
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$549
www.shoptoshiba.com

MEDIA RECEIVERS

Got a million MP3s but tired of burning CDs? Shoot your tunes to the stereo with a Wi-Fi media receiver. These machines come with remotes that let you choose songs and even playlists. Some handle more than music: The HP and Sony receivers grab photos from your PC and show them on your television screen. Sony's version, which works only with Vaio PCs and 802.11a networks, plays MPEG-2 video on your TV, too.

SONY ROOMLINK NETWORK MEDIA RECEIVER PCNA-MR10
$200
www.sonystyle.com

HP DIGITAL MEDIA RECEIVER [illegible]
$299
www.hpshopping.com

MOTOROLA SIMPLEFI WIRELESS DIGITAL AUDIO RECEIVER
$379
www.motorola.com

TERRA PLAYER TP-100
$895
www.terraplayer.com

MORTEN KETTEL, STYLED BY MICAH BISHOP

Intel has an urgent message for the wired world:

ers. But
. PDAs.
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capability,
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Vocera
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refrain from

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Gearing u

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The future of Wi-Fi
with 802.11b, the cu
by your Internet cor
and the first batch c
later this year. That
routers to choose fr

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STATION
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www.apple.com

LINKSYS WIRELESS
$199
www.linksys.com

POCKET PCS

The days of handhe
Pocket PCs are do-
miss a bell or a whi
print reader? Sure, w
about. This pumped
phone or Wi-Fi hot s

HP IPAQ POCKET PC
$699
www.hpshopping.co

Unw

Introducing Intel® Centrino™ mobile technology.
The new wireless notebook technology designed specifically for the wireless world. It not only lets you work, play and connect without wires, it enables extended battery life in a new generation of high-performance notebooks that are thinner and lighter. This is your invitation to unwire your life.

intel inside centrino™ MOBILE TECHNOLOGY

wire.

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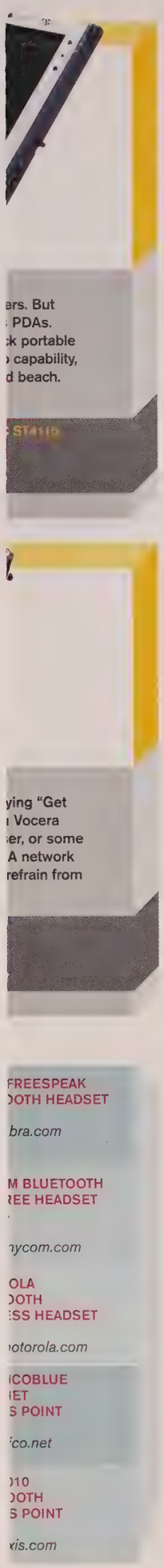


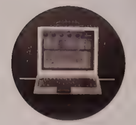
Intel engineering delivers built-in Wi-Fi capability and compatibility with leading networking hardware.

Untangle.

Your days of phone-jack hunting are over. Wires, nostalgia. In the wireless world, you're free to connect at thousands of hotspots across the globe. At an airport in Hong Kong. At a hotel lobby in Frankfurt. At a local café. In your own backyard. Intel Centrino mobile technology-based notebooks have wireless LAN capability built right in, so there's never a need for plug-in cards. This is the ideal technology for working wirelessly.

Uncompromise.

Wireless technology meets high-performance computing. Intel Centrino mobile technology-based notebooks are packed with the power to run today's most demanding business applications, as well as all the fun stuff. Download files in an office lobby. Edit family photos over lunch. Or just check your e-mail on the fly. It's a moveable feast of advanced computing power.

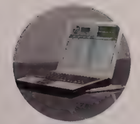


Intel invested billions of dollars to create this new mobile technology from the ground up. The result: more advanced computing power in a lighter form.

Unwire.

intel inside centrino MOBILE TECHNOLOGY

intel



Intel's new cool-running technology requires less space for cooling systems so it can be housed in smaller, lighter notebooks.

Unburden.

Feat of engineering or feat of magic? Intel Centrino mobile technology is designed to pack more computing power into a more portable form. Which is why major computer makers have seized the opportunity to design some of the lightest, thinnest notebooks ever. Once you slip one in your bag, you may forget you're carrying it.

Unstress.

The flashing battery icon is not your friend. Intel Centrino mobile technology is. It's engineered to let batteries last longer so you'll still be going strong during crunch time. No checking the clock. Just the power to work when you want, where you want, without being tethered by a cord. So go ahead, unwire.

Intel technology distributes power throughout the system intelligently, conserving vital energy for when you need it most.

pou

Gearing

54G ROU

The future of Wi-Fi
with 802.11b, the c
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and the first batch
later this year. That
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KubiWireless • LeisureLink • Megabeam Italia s.p.a. • Megabeam Networks Ltd.
NTT Communications • Orange SA • PCCW IMS Limited • Rikei Corporation
SOFTBANK BB • Spotnik Mobile • STSN • Surf and Sip Network • TDC Tele Denmark
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Dallas/Fort Worth International Airport • Denver International Airport
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Renaissance Hotels and Resorts • Residence Inn • San Francisco International Airport
San Jose Airport • Seattle-Tacoma International Airport • Sheraton Hotels and Resorts
Swedish Civil Aviation Administration (Stockholm Arlanda Airport)
Taiwan CKS International Airport • W Hotels • Westin Hotels and Resorts
And many others

Unwire now at intel.com.

Yes.

intel inside centrino MOBILE TECHNOLOGY

intel

WIRELESS CAMS

Webcams are so '90s. Today exhibitionists use Wi-Fi cams with built-in Web servers that beam live, hi-res photos to the anonymous masses. The image quality is stunning, and the refresh rates approach full-motion video. Dubious? Feast your eyes on a state-of-the-art fishcam: *www.dlink.com/LiveDemo.*

D-LINK DCS-1000W
$329
www.dlink.com

ADVANTEK NETWORKS CAS-300W
$295
www.advanteknetworks.com

TABLET PCS

Make no mistake, tablet PCs are full-blown Windows XP computers. But as they trim down, they're becoming almost as easy to carry as PDAs. Consider the NEC Versa LitePad. At 2.2 pounds, this 0.6-inch-thick portable is compact enough to take anywhere. It has built-in 802.11a and b capability, so you can write that novel and surf the Web from any white sand beach.

NEC VERSA LITEPAD
$2,399
www.necsolutions-am.com

FUJITSU STYLISTIC ST4110 WIRELESS LAN
$2,299
www.fujitsupc.com

WI-FI CARDS

Every expansion slot is precious in a PDA or notebook. If speed is your thing, shop for a new 802.11g card. Or, if you want both storage and connectivity, go with SanDisk's Connect. It uses flash memory to stow files in Pocket PCs and Windows notebooks, and links you up to Wi-Fi networks.

SANDISK 128 MB CONNECT DUAL-FUNCTION CARD
$130
www.sandisk.com

LINKSYS WPC54G WIRELESS-G PC CARD
$70
www.linksys.com

VOICE OVER WI-FI

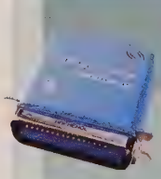
Clip one of these to your shirt and you can call a pal just by saying "Get me Jim." The sleek voice-activated badge uses Wi-Fi to link to a Vocera server, which connects you with another badge wearer, a cell user, or some poor schlub with a landline. This one-of-a-kind system is no toy: A network for 75 employees costs about $40,000 with PBX integration. So refrain from saying "Beam me up, Scotty!" unless you mean it.

VOCERA COMMUNICATIONS SOTEV
$27,000 and up
www.vocera.com

bluetooth devices

LIKE WI-FI, Bluetooth uses the 2.4-GHz band for data transfer. But its maximum range is 30 feet, limiting it to gadget-to-gadget communication. There are more than 1,000 Bluetooth products on the market, with 10 more introduced each week.

PRINT ADAPTERS



Carry one of these gizmos around and you can hijack any printer. Say you're in a client's office. Connect the adapter to the printer's parallel port, turn on your Bluetooth-enabled PDA or notebook, and – bam – you're printing up a storm.

ANYCOM PM-2002 PRINTER MODULE
$149
www.anycom.com

3COM WIRELESS BLUETOOTH PRINTING KIT
$219
www.3com.com

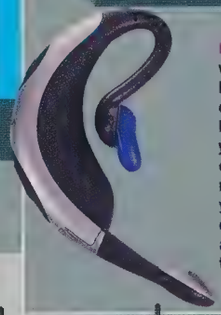
TROY WIRELESS WINDCONNECT
$179
www.troygroup.com

GPS RECEIVERS

Lose the connector cables, not your way, when you hit the road. Socket's GPS receiver works quickly and cordlessly with laptops, tablets, and PDAs.

SOCKET BLUETOOTH GPS RECEIVER
$399
www.socketcom.com

HEADSETS



It's hard to look important while you're talking into a headset with that wire dangling in your face. Bluetooth headsets let you cut the cord and make calls even while your mobile is tucked away in your briefcase. But watch out: Some are so comfortable, you might forget to take it off.

JABRA FREESPEAK BLUETOOTH HEADSET
$99
www.jabra.com

ANYCOM BLUETOOTH WIREFREE HEADSET AHS-10
$79
www.anycom.com

MOTOROLA BLUETOOTH WIRELESS HEADSET
$149
www.motorola.com

ACCESS POINTS

Power-efficient Bluetooth lets you link your devices to a network, and it won't eat up batteries as quickly as Wi-Fi. Caveat: The access point's price tag will chew through your wallet faster.

PICO PICOBLUE INTERNET ACCESS POINT
$419
www.pico.net

AXIS 9010 BLUETOOTH ACCESS POINT
$399
www.axis.com

MORTEN KETTEL, STYLED BY MICAH BISHOP

the way we work

BY JESSE SCANLON

Four stories from the wireless frontier.

At Conferences

Rael Dornfest
EMERGING TECHNOLOGY CONFERENCE CONVENTION CHAIR
O'Reilly & Associates • Portland, Oregon

It was clear Wi-Fi had transformed conferences when Qwest's then-CEO Joe Nacchio spoke at PC Forum in March 2002. Two audience members began to heckle in real-time blogs, and the crowd, reading along, turned against him.

I CHAIRED MY first wireless conference, the Peer to Peer, in January 2000. The first thing I noticed was that people weren't disappearing back to their rooms to check email between sessions. They'd just sit down in one of the common areas and log on. Because everyone was gathering in the same place, there was a lot more spontaneous discussion. Also, the sessions themselves became more interactive. Audience members would instant-message or email each other during a presentation as well as check out Web sites and info mentioned by the speakers. It really raised the quality of the presentations.

I remember at the 2002 Emerging Technology conference, Danny O'Brien set up a panopticon – a digital map of the conference layout with little icons representing attendees. You could move your icon to show what session you were attending, so that people could find you. But perhaps the most interesting wireless app is EtherPEG – code that scans the local network, captures a bit of every image being transmitted to and from laptops, and creates a montage of what people are looking at. At the Emerging Tech conference last year, someone posted the results to his weblog. When Larry Lessig was talking, the images went quiet. He's such an amazing speaker that people focused just on him. During other speakers, the images flowed like wine!

Remember Clay Shirky's idea of the lazy Web – that if you want something built, you just mention it on the Net and someone will build it? Mention an idea at a Wi-Fi conference – Steven Johnson's concept of Google Share, for instance – and within 48 hours there'll be three or four implementations of it.

AMANDA MARSALIS

EAT IN, CARRY OUT, OR LOG-ON.

Heads up people. Your next visit to McDonald's® could take you all the way to the Internet. Intel® Centrino™ mobile technology and McDonald's are working together to get you connected without wires. Now when you come into a participating McDonald's restaurant displaying on the door, you'll find easy, convenient, high speed wireless LAN access. Visit www.mcdwireless.com for an up to the minute list of participating locations and other important details.

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smile™

On the Farm

Terry Hanks
MARKETING MANAGER
John Deere Ag Management Solutions • Urbandale, Iowa

Farmers who once just relied on gut instinct are now crunching numbers while working the field. High-end tractors, equipped with sensors, onboard computers, and GPS, are driven by data ranging from temperature to amount of seed released.

I GREW UP in Iowa, and you just don't typically think of *Star Wars*-type products in agriculture. So it was a shock for me when John Deere introduced its first wireless machine in 1996 – a combine that could measure the moisture of the crop and how much is harvested.

I was talking to a fellow the other day, and he said, 'I'll never buy that thing.' They think they don't need some whizbang satellite service. But you get them in the seat of the tractor, and after one trip down the field and back it's a done deal. At a basic level, they're less tired at the end of the day because AutoTrac uses differential GPS to determine the precise position of the tractor and then takes over the steering. Because the rows are more exact, the farmer isn't wasting seed or fertilizer by overlapping. One farmer told me he usually buys 11 percent more fertilizer and seed than he thinks he'll need, just to account for spillage and overlap. This year, he used our ag-management system and ended up with only 9 percent more chemicals than he needed.

Low prices and imports are forcing farmers to be more efficient. Then there's the weather. Planting, cultivating, and harvesting windows are shrinking, and farmers have to be that much more efficient. Basically, you have good weather and bad weather, and when it's good you've got to be up and running. One farmer I met was planting 24 hours a day to take advantage of the good weather. He could work right through the night because of the satellite-controlled steering. We can steer tractors via the sky!

All that information is transmitted wirelessly and available 24 hours a day. If a machine breaks down, the system emails the service department.

JEFF SCIORTINO

In Hospitals

Larry Nathanson
DIRECTOR OF EMERGENCY MEDICINE INFORMATICS
Beth Israel Deaconess Medical Center • Boston, Massachusett

Hospitals use wireless to help tame their barely controlled chaos, though they can't always use off-the-shelf gear. Boston's Beth Israel developed its own low-power cellular network that doesn't interfere with medical equipment.

I CAN'T IMAGINE doing my job without wireless. We have wireless laptops for ER registration. That means we can start working on patients as soon as the medics wheel them in. It used to be that we'd have very limited background knowledge on a patient until that data had been entered into the dashboard system. Now we have all of the critical information immediately because the medics give it to an intake nurse sitting right there with us in the ER core.

The major win with wireless in the emergency department is the cell phone service. I was against it in the beginning. I didn't want to have to interrupt a conversation with a patient to take a call. But I found it actually improved patient/doctor relations. I used to be paged when I didn't answer my office phone. Even if the question was very simple, I would have to leave the patient's room and then invariably I would run into two or three other people who needed to talk to me and it would take me 20 minutes to get back to finish the conversation. Now the cell phone rings – it's a mobile hospital extension – and I answer the question right there in the room and hang up. It's an interruption, but only 10 seconds, and I end up spending a lot more time with patients. Plus, when patients can hear that it's a critical medical issue that's causing the interruption, they tend to be less angry. The nurses love it, too, because they know they can reach me in a second.

I was a programmer before I went to medical school. So I sit there in the emergency room and I think, 'Wouldn't it be great if … ?' Then I figure out how to do it. I'd love to do bedside electronic charting and order entry. That's my Holy Grail.

MATT GUNTHER

At the Theme Park

Brad Tyler
IT PROJECT MANAGER
Universal Studios • Hollywood, California

Where there are theme parks, there are lines. Universal Studios is helping to shorten the wait at the front gate using roaming ticket sellers armed with Wi-Fi-enabled devices and belt-mounted printers.

WE ROLLED out the wireless ticketing system on the Fourth of July, probably our highest attendance day of the year. I gave a unit to one ticket agent and took her out into the lobby. It was packed, and we quickly found our first customer. Within minutes, we had people getting out of line and crowding around us. I knew at that point that we were onto something.

It really changes the job. If you're waiting in the line, you're tired, you're hot, and you just want to buy your ticket and get inside as quickly as possible. But when the ticket seller is outside the gate, and you can just walk up to him, the interaction becomes more of a conversation. The sellers have essentially become hosts. On many occasions, I have seen guests planning out their day with the ticket seller, asking about the best time to visit Jurassic Park or the best place to get pizza.

A lot of visitors aren't native English speakers. For them, the roaming ticket sellers have been great. When you're choosing from among 10 long lines, you have no idea who the seller is at the head of the queue. But our wireless sellers wear badges that identify them as bilingual.

Your first experience of the day is a lasting one. If you're waiting in line for half an hour and you're sweaty, that experience tends to stay with you. Any industry that deals with lines can apply this technology.

Desktop computer systems require the customer to wait in line – the data is anchored to the ground. Wireless allows you to go to the guest, rather than having the guest come to you. And wireless solutions are scalable: We can put 50 ticket sellers out there if we need to. The whole paradigm of waiting in long lines is gone. ■ ■ ■

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- Increased productivity anywhere, anytime

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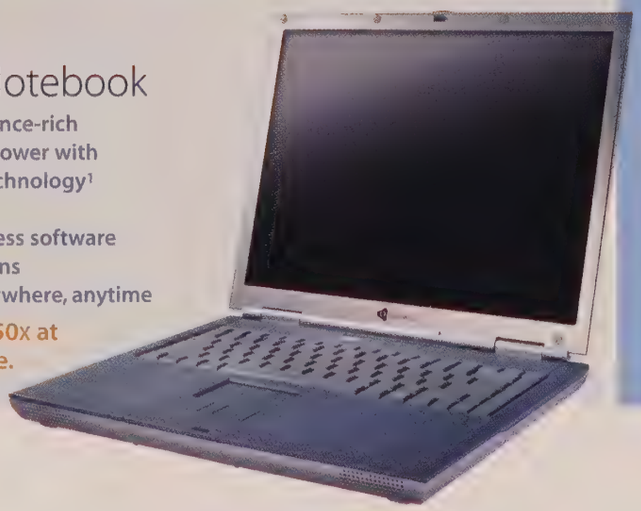

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good-bye 3G – hello wi-fi frappuccino

BY DAN BRIODY

Cellcos bet big on third-generation wireless – and took a big hit. Now T-Mobile's John Stanton has a grand convergence plan. Starbucks is just the beginning.

CASARAMONA.CH

AS T-MOBILE USA'S John Stanton tells the story, his company's future was changed by a chance meeting with Michael Dell, chair and CEO of Dell Computer. During the 2001 Allen & Co. CEO schmoozefest in Sun Valley, Idaho, Stanton sat down for drinks on a sun-drenched patio and learned that Dell planned to build Wi-Fi into most of his company's laptops. It was a bombshell.

Stanton, chair of T-Mobile, had been spending much of his time discussing business trends with cell phone makers and network equipment providers, trying to figure out how to offer wireless broadband to mobile phone users. Like his peers in the cellular industry, Stanton thought Wi-Fi was just another open spectrum technology with no place to go – a fad like HomeRF and Bluetooth, a techno-hobbyist's Tinkertoy, a network for wireless weenies. The real solution to broadband wireless was 3G; it was just going to take a bit longer than expected.

But here was Dell with his plan to make devices that access the Internet wirelessly, and he's all about Wi-Fi. "Michael said they were going to build Wi-Fi into a significant portion of their laptops," recalls Stanton. "I was shocked. Up to that point, I thought [Wi-Fi] was nothing but more overstated expectations. But here was a guy that was deeply committed. It was at that point that I realized Wi-Fi was real. That was the seminal event."

The world of wireless communications has turned upside down. A few years ago, it was generally accepted that your phone would be your ticket to the wireless universe, and the cellular service providers, offering more and more services and bandwidth, would be at the center of the action.

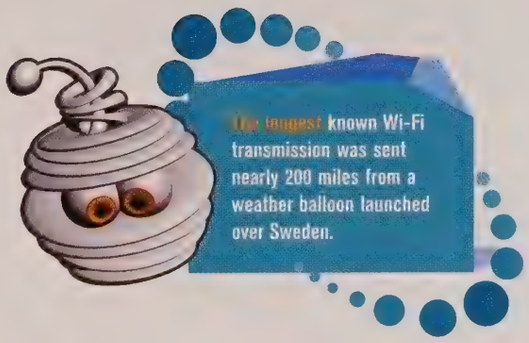
The reality, as Stanton learned, is far different: Cellular was not cutting it. Its data and multimedia services were slow and ineffective. Computer makers wanted a wireless broadband solution, and they wanted it right away. They wanted Wi-Fi.

Stanton came to this conclusion just as T-Mobile was embroiled in a fierce political and financial battle. The company was born a year earlier, when Deutsche Telekom announced it would spend an eye-popping $50 billion to acquire VoiceStream, then the only US carrier with a network based entirely on GSM, the technology used widely by European carriers. Analysts immediately criticized the company for overpaying, and the acquisition (ultimately a mere $30 billion) coincided perfectly with the bursting of the Internet bubble, the cratering of tech valuations, and the beginning of a long, torturous decline in capital spending by wireless carriers. It was horrendous timing.

For a while, it seemed T-Mobile's salvation depended on 3G, the next generation of cellular technology, to revive the firm's dwindling revenue. Though there are many different paths to 3G (CDMA 2000, WCDMA, TDS-CDMA), the end result was to be the same: to make the Internet wireless, with a quantum leap in the capacity and speed of the networks. This was a pretty thrilling vision, so much so that the overheated European carriers got caught up in a bidding war for 3G spectrum licenses. Altogether, they ended up spending $100 billion just for the right to provide the service; the actual cost of building the networks and otherwise rolling out the technology would likely double that.

But the first trials of the favored European 3G standard, WCDMA, turned up troubling technical limitations, from disappointing data rates to high power consumption. And suddenly the massive debt that the carriers, including Deutsche Telekom, had taken on for the 3G landgrab started to look like a crippling mistake.

What this meant was that 3G was certainly not going to happen as planned, and might not happen at all. So T-Mobile settled on a more modest path: It quietly began upgrading its GSM networks to a cheaper, more evolutionary technology called GPRS (also known as 2.5G) and waited for something to happen. Rumors abounded that T-Mobile was on the block. By the middle of 2001, even GPRS was labeled a major flop in Europe, with slow speeds and very little customer adoption.



Meanwhile, back in the US, T-Mobile watched as Sprint PCS and Verizon got their own 2.5G networks up and running using the competing CDMA standards, which were cheaper to deploy and offered faster speeds. The situation started looking desperate, with T-Mobile seeming to fall behind. But a revolution had been brewing, a movement to elevate a grassroots technology into a worldwide broadband solution.

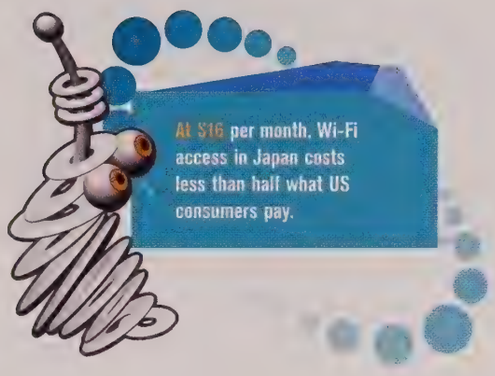
Wi-Fi was an underdog from the outset. Built for data transmission across local-area networks with a radius of only about 150 feet, it was best suited to homes and corporate campuses. But in light of the 3G fiasco, it had some serious advantages: high speeds and low cost. Cellular carriers didn't know what to make of the new technology. Fear was the order of the day. "Wi-Fi was about the worst thing that could conceivably happen to them," says Richard Dineen, a wireless expert with London-based market research firm Ovum. "It was unlicensed spectrum with no barriers. Unsurprisingly, they kicked and screamed and didn't welcome its arrival." Some even talked about trying to kill Wi-Fi by complaining that unregulated wireless tech-

George Allen and Barbara Boxer

the senators

PEOPLE TO WATCH

George Allen is a pro-life, pro-gun Republican conservative from Virginia. Democrat Barbara Boxer is a two-fisted California liberal. But the two senators have forged an alliance over a single issue: getting wireless broadband into businesses and homes. In January, Allen (whose state includes the Dulles technology corridor) and Boxer (who represents Silicon Valley) unveiled the Jumpstart Broadband Act of 2003, which would force the FCC to make unlicensed 5-GHz spectrum available. The bill got a boost in February, when the Department of Defense, which currently controls that range, announced an agreement with tech companies to relinquish some of the spectrum. – Matt Bai



nologies risked interfering with licensed spectrum and should be curtailed.

T-Mobile, however, was in too much trouble to waste time with tantrums. After his fateful meeting with Michael Dell, Stanton returned to the company's Bellevue, Washington, headquarters and set in motion a series of events that would radically alter Wi-Fi's fortunes – and, he hoped, T-Mobile's.

Stanton heard that Starbucks, another Seattle-area company, was dissatisfied with the Wi-Fi network MobileStar was setting up for it, and he saw his opportunity. "MobileStar was defaulting on its obligations, and Starbucks was looking for another provider," says Stanton. "We reached an agreement. Starbucks terminated the MobileStar contract, MobileStar went bankrupt, and we bought them out of bankruptcy."

T-Mobile put $100 million behind its Wi-Fi initiative and began lighting up 2,000 hot spots in Starbucks stores around the country. In so doing, T-Mobile tipped the scales in the battle for next-generation wireless services. It was a classic if you can't beat 'em join 'em moment. One by one, carriers – even ones that were betting big on 3G – began to recognize the promise of Wi-Fi. Sprint PCS invested in Wi-Fi service pioneer Boingo. AT&T announced a joint Wi-Fi venture with Intel and IBM called Cometa. While neither AT&T nor Sprint has announced plans to provide Wi-Fi service to their customers, that moment can't be far away. Even up-and-running 3G networks can't compare with Wi-Fi's speed and capacity.

Wi-Fi had fast become the thing carriers fear most: a disruptive technology. How disruptive? T-Mobile is now fiercely ambivalent about 3G as the future of wireless data. "We've always been an advocate and supportive of 3G, but frankly never saw a way to get it done in the US," explains Cole Brodman, senior vice president and chief development officer at T-Mobile and the man who hatched a business plan from Stanton's enthusiasm. "We looked at Wi-Fi as a disruptive technology and a chance to get something done. On the 3G side, we are in the wait-and-see mode, and we are working on evaluating some other technologies."

The goal for T-Mobile and similar wireless providers is a seamless network, where one device hops from the Wi-Fi network to the cellular network with ease. Call it communications convergence: a blissful harmony of technologies, invisible to the consumer, that allows broadband access anywhere, anytime, from any device. Despite significant technical hurdles (not the least of which is a lightning-quick power drain), chipset makers like Intel and Qualcomm are experimenting with built-in Wi-Fi, and dual-action handsets are on their way. Samsung and HP have already shown PDA-based Wi-Fi phones; Motorola has promised one by the end of the year.

Though T-Mobile is the only carrier that has publicly disclosed plans to converge Wi-Fi with cellular, others are working on integrated networks. In February, at the 3GSM Congress in Cannes, Texas Instruments floated a scenario that includes cellular microbase stations combined with Wi-Fi hot spots to blanket dense urban environments.

In the meantime, T-Mobile is still tweaking its strategy. As the company evaluates various 3G technologies, the Starbucks Wi-Fi experience so far has been only a limited success, with reports of just 20 Wi-Fi users per day even in busy locations. To spur demand, in March T-Mobile slashed Wi-Fi access prices, and it's pushing ahead to unite its Wi-Fi and cellular networks. The ultimate goal: offering customers the ability to roam between the two and get one bill at the end of the month.

THE ULTIMATE GOAL: TO ROAM FREELY BETWEEN WI-FI AND CELLULAR NETWORKS – AND GET ONE BILL AT THE END OF THE MONTH.

If T-Mobile gets it right, the company may soon have a customer base accustomed to using phones to move around big data and multimedia files. That's not far from the previous 3G vision – except for the 3G part, which T-Mobile barely mentions anymore. Wi-Fi, even in its young and developing form, has everything to do with that. ■ ■ ■

Dan Briody (danbriody@yahoo.com) ***is a freelance writer and author of*** **The Iron Triangle: Inside the Secret World of the Carlyle Group.**

Dewayne Hendricks – the ultrawideband tinkerer

PEOPLE TO WATCH

Entrepreneur Dewayne Hendricks helped bring wireless broadband access to Mongolia, to Native American reservations, and most recently to isolated schools in Thailand. A member of the FCC's prestigious Technological Advisory Council, he says it's time to wrest control of the airwaves from the government. And he's looking beyond Wi-Fi to technologies like ultrawideband, cognitive (software-defined) radio, and dense-packet radio topologies that could soon make licensing unnecessary. Consider the benefits: wireless access for a nearly unlimited number of people, choreographed by smart software in their devices, not by Beltway bureaucrats. – Brent Hurtig

ILLUSTRATION BASED ON PHOTOGRAPH BY MICHAEL SCHMELLING

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palm pulls the plugs

BY
BRAD STONE

Free at last: A case study in learning to love the unchained corporation of tomorrow.

NATHAN FOX

IT WAS A SCENE to give any IT guy chills: 12 top executives of Palm Inc. were meeting in the boardroom last December. As usual, attendees had opened their laptops, unsheathed their PDAs, and were attempting to log on to the company's wireless local-area network before getting down to business.

But this time, the network wasn't working in half of the room. CEO Todd Bradley and his staff were getting nothing but sluggish connections and frustrating error messages. Mike Allison, director of the company's global tech infrastructure, quickly found himself on the receiving end of an angry phone call from his boss, CIO Marina Levinson. "I don't get yelled at that often," Allison recalls, "so there must have been some urgency."

Allison was ordered to diagnose and fix the problem immediately. But he could find nothing wrong with the company's network or the building's Wi-Fi nodes. Finally, he discovered that someone had set up a so-called rogue network – an unauthorized Wi-Fi hub – and it was crowding out the corporate LAN at the access point serving the executive conference room. The execs sitting around the table were inadvertently logging into the rogue node – a dead end.

With the help of a laptop and Kismet sniffer software, Allison identified the position of the rogue network. To his astonishment, its signal emanated from the office of Eric Benhamou, the chair of Palm and 3Com.

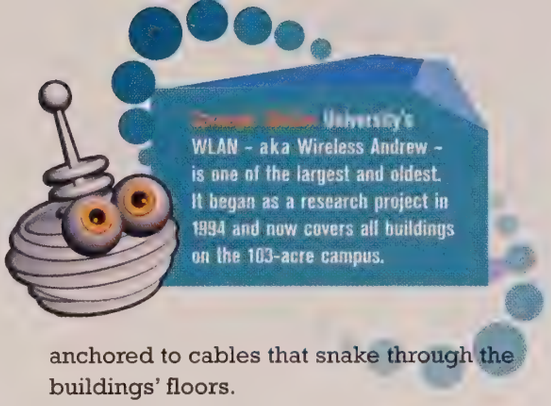
A pioneer of computer networking in Silicon Valley, Benhamou is also an Apple enthusiast and a lover of Wi-Fi. He had brought from home a Mac laptop and an Apple AirPort, which he had installed himself on the corporate intranet. Allison politely informed Benhamou that his home-brewed wireless network was, well, mucking up the works. Allison turned it off, and the Palm executive boardroom was once again bathed in glorious, empowering radio waves from a legitimate 802.11 access point. Connectivity was restored, and all was well.

In its Silicon Valley offices, Palm has one of the most sophisticated wireless networks anywhere. Eighteen Cisco Aeronet nodes cover 140,000 square feet across all three Palm buildings in Milpitas. Of the 700 employees on the campus, more than half have Wi-Fi cards. Palm also put in 30 Bluetooth access points throughout the offices to connect (albeit slowly) PDAs to the Internet.

Palm doesn't just want to unshackle its employees. The company needs to fully embrace a wireless workplace so it can road-test devices and stay on top of Wi-Fi trends. Even more important, it wants to remake itself into a dynamic illustration of a flourishing unplugged workplace, to help convince penny-pinching execs at other companies that it's worth bringing the technology to their offices as well.

Palm's future depends on it. Gone are the days of its first Pilot, when a portable digital calendar and phone directory were enough to persuade thousands to fork over $300. Those features are now commonplace in myriad devices. Today and for the conceivable future, the development of PDAs revolves around getting businesses to embrace wireless networking. Microsoft, Hewlett-Packard, Research in Motion, and a crowd of mobile-phone vendors in Asia and Europe are all elbowing their way into the market. Palm is on a mission to convince the world that it knows the business better than anyone.

For now, Palm's transformation is underwhelming. Employees are, as expected, working away from their desks. Outside headquarters, several sit tapping away at laptops, enjoying the Valley's warm sun. And in an empty conference room near the lobby, another employee, taking refuge from his cubicle, answers email. But most still work in their cubes, tethered to their Ethernet-hungry desktops and their voice-over-IP telephones – both of which are anchored to cables that snake through the buildings' floors.



Unlike far-flung university campuses and factory floors, where mobile connectivity is often the only alternative, corporate America has yet to fully embrace wireless networks. CIOs are nervous about security vulnerabilities. Companies know they can never fully cut the tether so long as workers need docking and recharging stations. And many firms are simply too comfortable in their use of Ethernet, a technology that contractors routinely install in all new office buildings.

For now, the heart of Palm's wireless transformation is in that cherished universal experience: the meeting. One of the most popular software apps around the office is Colligo Meeting, which allows six PDA owners, sitting up to 30 feet apart, to instruct their devices to find the first mutually acceptable meeting time. Once connected, colleagues can volley instant messages – a real-time meta-conversation that underlies whatever's transpiring. Palm staffers also use a Bluetooth application called Blueboard to scrawl messages to each other on the screens of their PDAs.

The downside of all this connectivity is, of course, more intrusion into what was formerly known as free time. "It used to be that just the cell phone could get you. Now I'm available on every channel, every hour of the day, if I choose to be," says Eric Klein, a group manager.

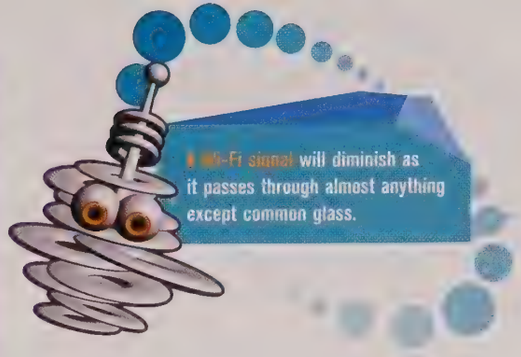
It also means more goofing off. More than once, says Klein, he's been running a meeting and noticed a colleague's fingers

Doug Karl — the apple farmer

PEOPLE TO WATCH

Doug Karl invented the Apple AirPort, built the first device to translate Ethernet input into wireless output, and wrote access point software licensed to companies like Sony, Dell, and IBM. He is also founder and president of KarlNet, a growing Dublin, Ohio-based company whose flagship product is TurboCell – a supercharged protocol that can be "flashed" into inexpensive Wi-Fi gear, optimizing it for high-performance, long-range use outdoors. The improvement is especially useful in rural areas, where access points can provide entire communities with broadband. An answer to the last-mile problem? "It's more like the last 20 miles," he says. – Joseph Portera

ILLUSTRATION BASED ON PHOTOGRAPH BY JEFF SCHARNO



feverishly pecking away at a laptop or PDA. "There's no way a human can reply to an email and appear to be paying attention," he says.

Larry Birenbaum, who oversees wireless strategy at Cisco, says fighting the distraction of always-on Net access during meetings is simply a matter of developing a new code of conduct governing its use. "Imagine the caveman days," he says. "They had some meeting, and all of a sudden, someone brings in a chisel and stone to take notes. That must have been equally distracting. Over time, you get used to it."

Neither Palm nor Cisco thinks this is enough of a problem to restrict when employees can use computers or handhelds. But other Valley companies, like Wi-Fi hardware maker Proxim, ban laptops and other connected devices from some high-level powwows. "Just like the mobile phone, you have to set limits," says Proxim exec Maureen Smith.

Palm's wireless culture started, as always, with the nerds. In late 2000, when the company still operated from the campus of its former parent, 3Com, the engineering group tired of trying to get the old-school IT department to adopt the new 802.11b technology. So they decided to set up a network themselves. To avoid getting caught, "we had to somehow camouflage [the antennas]," sysadmin Darryl Lee recalls. The solution: Lee punched holes in empty Palm V and VII boxes, placed the antennas inside, and scattered them around the building. He and his cohorts put up 12 hidden nodes around two buildings, typically in cubicles near conference rooms. "Only the telltale cable [running to the antennas] signaled anything unusual," he says.

Yet the network was insecure. In 2001, some computer scientists at UC Berkeley announced they had cracked WEP, the wireless encryption standard, which was the only thing protecting Wi-Fi-enabled networks. Palm employees recall being able to drive down Tasman Drive in San Jose and easily hop onto Cisco's nascent Wi-Fi network, called Tsunami. Although the Palm setup was similarly vulnerable, at least it was small enough to hide from most such war-driving detections. And if the nerds' endeavor had risked exposing Palm's corporate LAN to hackers (for a short time), it was worth it. The outlaw experiment gave Palm a compelling glimpse into the future.

At the time, the company was betting big on the Palm VII, which could download email and calendar appointments over the Mobitext pager network. But just as word of Palm's Wi-Fi network spread from one employee to another, Intel subsidiary Xircom announced its first 802.11 "sled." Attached to a Palm m500 or 505, the sled let users surf the Net over Wi-Fi and get email hundreds of times faster than they could with the Palm VII. Soon, employees were discarding their Palm VIIs and upgrading their older models with the new Xircom attachments. And inside the office, workers preferred to connect via 802.11 rather than over sluggish wide area networks. Palm got the message: In August 2002, when the company moved to its Milpitas offices, Palm put in its current network of Wi-Fi and Bluetooth nodes. For security, these networks were placed outside the corporate firewall and safeguarded with a virtual private network that uses sophisticated encryption to keep away intruders. The experiment to prove that going wireless is worth it had officially begun.

When the first corporation pulls the plug entirely, "workers will become totally unchained," says Kenneth Berger, founder of San Francisco-based consultancy LogX Technologies. "Corporate culture will be changed in ways we can't fully understand." Employees will be free to roam anywhere they're needed. Conferences will take place spontaneously, no matter where the participants are. Phones may look like Star Trek badges pinned to clothes.

When Palm goes totally wireless, it will be an ironic moment in Silicon Valley history. Palm was, after all, bought and later made independent by 3Com, which was founded by Bob Metcalfe in 1979 to capitalize on his invention of Ethernet. Twenty-four years later, 3Com's protégé may help to make the wired network obsolete. ■ ■ ■

TO CAMOUFLAGE THEIR SECRET WI-FI NETWORK, ENGINEERS HID ANTENNAS INSIDE EMPTY PALM BOXES AND STASHED THE NODES IN CUBICLES.

Brad Stone (bstone@gearheadsthebook.com), *a Silicon Valley correspondent for* Newsweek, *is the author of* Gearheads: The Turbulent Rise of Robotic Sports.

Don Samuelson

the builder

PEOPLE TO WATCH

The information revolution mostly skipped over southwestern Chicago, where grinding poverty makes high technology seem like a luxury. But by using relatively inexpensive wireless networks, real estate developer Don Samuelson plans to connect the part of town to the rest of the world. A former assistant director of the Illinois Housing Development Authority, Samuelson owns or manages more than 2,000 units of low-income housing in the area. With $50,000 worth of mostly donated Motorola equipment, he aims to make southwestern Chicago broadband-accessible. His first project: an antenna atop his New Englewood Terrace apartment building to provide broadband access over a 10-mile radius. – Alex Ulam

ILLUSTRATION BASED ON PHOTOGRAPH BY JEFF SCIORTINO

Investing in the Future of Wi-Fi

Intel Capital, Intel's strategic investment program, is one of the largest worldwide corporate venture programs. Intel is investing in an ecosystem of companies with wireless programs focused on accelerating infrastructure deployment, removing barriers to adoption, developing innovative services, and harmonizing global technical standards. The investment in businesses developing Wi-Fi technology and services is another step in the effort to grow unwired mobile computing worldwide. To learn more about these companies, visit www.intel.com/capital.

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20,000 nodes or bust!

BY LUCAS GRAVES

Everybody talks about the Wi-Fi future. Cometa CEO Larry Brilliant is building it – with some help from three little outfits called IBM, Intel, and AT&T.

CASARAMONA.CH

THREE YEARS AGO, while at the helm of the now-defunct Aerzone, Larry Brilliant burned through almost $100 million trying to construct a Wi-Fi network for the country's airports. At the end of 2000, he gave up, citing lack of demand. But things have since changed a great deal in the unwired world, and now Brilliant's back with a far more ambitious plan. As the head of Cometa Networks, he intends to build a 20,000-node nationwide Wi-Fi network – before 2007 is out.

"Simply put, we will be the biggest provider of wholesale 802.11 bandwidth in the United States," Brilliant says from the company's San Francisco headquarters. "No place in the top 50 metro areas will be more than five minutes from an access point."

Cometa seemed to appear out of nowhere last December. Backed by AT&T, Intel, and IBM, the outfit had been percolating quietly under the code name Project Rainbow for the better part of a year. Its partners dropped $1 million to study the potential market for Wi-Fi and develop a business plan. "We spent nine months locked in a room with 40 full-time professionals," says Brilliant, who is Cometa's acting CEO until he can find someone to run things day-to-day. "There's hardly anyone in wireless we didn't talk to – and because of the companies involved, they all called us back."

Members of the research team knew they could count on PC manufacturers to begin including 802.11 gear as standard equipment in their new notebooks, which would jump-start demand. They also found that corporations were beginning to embrace the technology. The question was where to position Cometa. It needed to find users who would pay for access.

Cometa's plan calls for AT&T to build and operate the network, helping defray the massive infrastructure costs. IBM will handle backend billing systems, and Intel will provide capital as part of its pledge to invest $150 million in promising Wi-Fi ventures around the world. Additionally, Cometa will avoid the enormous cost of building a brand by acting exclusively as a wholesaler. It will supply bandwidth to service providers who in turn will act as resellers.

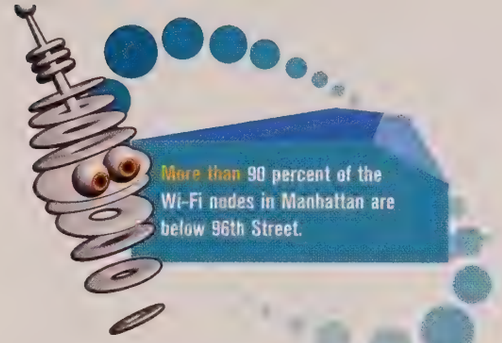
To the technology partners, the reasons to be involved with Cometa are obvious. Intel's Wi-Fi chipsets get a boost in demand. AT&T adds another flavor of network to its menu, and IBM's Global Services arm gets to turn its corporate clients on to a whole new technology.

Of course, even with Cometa's blue-chip backers, there's no guarantee that the plan will work. There's been a conspicuous lack of interest in paid Wi-Fi service so far. Underwhelming demand has already claimed at least three early Wi-Fi service providers, and others – Boingo and Wayport – have run into similar trouble building their subscriber base. T-Mobile runs the biggest subscription 802.11 network anywhere, with more than 2,000 nodes around the country, mostly in Starbucks cafés.

But like T-Mobile, some of Cometa's stiffest competition comes from the free networks popping up like daisies after a spring rain. Public Wi-Fi experiments in cities from Barcelona to Long Beach have shown that it can cost just a few thousand dollars to set up a free network.

As independent tech vendors emerge with security solutions for these free networks, Cometa could have a hard time convincing anyone they should pay for access.

Yet these issues don't concern Brilliant nearly as much as the company's core challenge: a massive landgrab. The b-school mantra that fast-food chains are actually in the real estate business applies to Cometa also; success depends on properly locating access points. And it has to be everywhere before it can sell anywhere. "We can't say we're in 60 percent of Hyatts. We have to say we're in all of them," Brilliant explains of his effort to recruit resellers. "No one's going to buy a nationwide, all-you-can-eat model before you've got 20,000 nodes."



One of the most interesting aspects of Cometa's strategy is its target market – not executives jetting from JFK to SFO, but "windshield warriors," the insurance and pharmaceutical salespeople who roam their districts in wrinkled suits and mid-size sedans. Researchers say the market for "mobile field sales applications and services" will grow eightfold, to $1 billion, over the next four years.

With secure network access from a parking lot or even a gas station, these salespeople could use time between meetings to catch up on email, file reports, and update accounts – meaning more sales calls and fewer hours in front of the computer once they get home. "Windshield warriors don't go to hotels or to airports, they go to McDonald's," says Dean Douglas, an IBM vice president who has worked for Cometa from its inception. "They have a lot of dead time, but they're not in a place where they can immediately go and do some work." And so, naturally, Cometa plans to roll out hot spots under the golden arches, too.

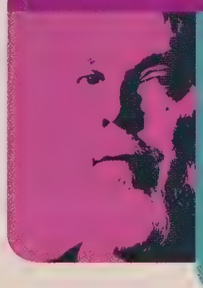
After his Aerzone failure, Brilliant naturally wants Cometa to be a great commercial success. But if not, the company can count victory by achieving its backers' main aims: creating a critical mass of hot spots, making public Wi-Fi practical, and driving mainstream consumer demand. That's great for Cometa's partners, but it would also thrill other companies across the technology industry, making Wi-Fi the next big thing Silicon Valley so desperately needs. ■ ■ ■

Lucas Graves (lucasgrv@yahoo.com) ***is a freelance writer living in New York City.***

David Reed

the visionary

PEOPLE TO WATCH



In David Reed's perfect world, there'd be no cell phone towers. The MIT Media Lab adjunct professor envisions wireless devices communicating with one another, acting like tiny transmitters. Wireless spectrum, he says, is "the ultimate renewable resource," and because radio signals are made of photons that can pass through each other, it's also "expandable and scalable without bound." Reed and fellow researcher Andy Lippman founded the Viral Communications project to explore how cooperating devices could one day make cellular carriers, cable companies, and ISPs obsolete. "We expect everything to be able to connect to everything else," says Reed, who also helped develop the original Internet protocols. "And we don't want to pay a monthly fee for each device."
– Mark Frauenfelder

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Intel's built-in 802.11b wireless LAN capability eliminates the need for adapter cards.

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beyond wi-fi

BY
XENI JARDIN

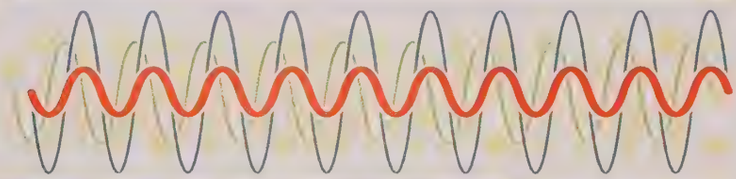
The 5 next big things.

ULTRAWIDEBAND

This superfast, short distance wireless technology promises data speeds 10 times faster than Wi-Fi. It works by transmitting its signal over a wide swath of frequencies, including licensed bands, at such a low power that it doesn't interfere with the other occupants of the spectrum.

That's the idea, anyway. In February 2002, the FCC approved UWB for short-range applications despite howls of protest from the FAA and wireless carriers like Verizon and Sprint. Early tests by NASA, among others, raised questions about potential interference with airplane collision-avoidance systems and existing wireless networks. The FCC ruling allows development to proceed while these questions get addressed.

If it works, UWB could give rise to a new generation of portable and home entertainment products. Digital video, audio, or television streams could be managed with UWB quality equal to a hardwired system, and its high speed and low power consumption make it perfect for home networking. First-generation UWB products are expected in late 2003, but it could be five more years before UWB is widely adopted.



SOFTWARE-DEFINED RADIO

Just as remote controls proliferate in our living rooms, our lives are filling with incompatible wireless devices, from cell phones to baby monitors. Even if they have very different functions, these gadgets share many of the same basic technologies: transmitters and receivers, batteries and antennas. Universal remotes exist; why not universal wireless devices?

That's the inspiration for the growing software-defined radio movement. Rather than determine a wireless device's function with dedicated hardware, gadget makers can keep the electronics to a bare minimum of generic radio chips and control them with software, which can morph endlessly. Think of the difference between a PC and a cash register: Both may be computers, but one is a general-purpose device whose function is defined by software and can be changed at will, while the other is hardwired for a single task.

Software-defined radios can reconfigure themselves automatically to recognize and communicate with each other. This could impose order on the current Babel-like chaos of competing wireless standards (CDMA, GSM, TDMA, and countless others), transforming today's rigid networks into nimble, open systems. The big payoff: improved system performance, cheaper service cost, and seamless roaming. With instant reprogramming, you can carry a single gadget for multiple uses. A cell phone becomes a garage door opener, which morphs into a mobile gaming device, which then – presto! – turns itself into a TV remote. But none of this will happen overnight. The key digital signal processor chip is still under development. Watch for new Intel CPUs to include a type of software-defined radio that will likely be able to adapt to different wireless LAN standards. If all goes well, software-defined radio will make its way into cell phones and other mobile units by 2008.

MESH NETWORKS

One of the most highly anticipated technologies, mesh networking turns nearly any wireless device into a router, creating an ad hoc network. Members of a network no longer rely on a central routing hub to distribute data – instead, the information hops from one user's gadget to another until it gets where it's going. Each connected cell phone, PDA, or laptop pitches in a little routing power, forming a spontaneous, temporary, wireless cooperative. The advantages include cheaper service and wider coverage areas. Plus, proponents claim mesh can send data at speeds above 5 Mbps – about 10 times faster than DSL. Using higher bandwidth protocols like UWB, those speeds could reach 500 Mbps. But there are challenges: How will data remain secure as it passes from device to device before reaching its destination? How can participants be billed for connectivity? And dynamic routing can be complex; these systems slow to a crawl if traffic is poorly managed.

WIRELESS PERSONAL AREA NETWORKS

This short-range technology lets everyone have their own little local wireless network. Within a personal bubble of operating space, PCs, PDAs, mobile phones, and digital music players detect one another and interact. Defined by the Institute of Electrical and Electronic Engineers as a zone of at least 10 meters (32.81 feet) around a person, WPANs could forever eliminate scores of cable and wire that booby-trap homes and offices. In their place: wearable, smart computing devices that converse on the fly, as well as new mobile digital payment systems and personal security technologies.

Devices within a WPAN create a flow of machine-to-machine communication that personalizes services spontaneously. But managing device interoperability, maintaining always-on connectivity between machines, and ensuring that personal information stays safely inside users' bubbles won't be easy. General Atomics, IBM, and Philips are among the tech titans said to be exploring WPANs. Watch for these networks to proliferate within two to five years.

ADAPTIVE RADIO

It's only polite to listen before speaking so as not to interrupt, but that's something radio is still learning. Adaptive radio is a move in this direction: a technology that lets wireless devices scout out the spectrum wherever they are, avoiding interference by tuning their transmissions to the available gaps. Such devices can modify their power, frequencies, or timing to suit the environment they find themselves in, making such adjustments at occasional intervals or constantly checking and changing as airwave traffic shifts around them. Some also rely on smart antennas that use phased-array technology to aim their transmissions at the receiver, rather than broadcasting in all directions like most antennas.

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The company that helped wire the world is driving the effort to unwire it. Intel is bringing together leading service providers, technology manufacturers and various retail locations, including hotels, airports and cafés, to make wireless access universal. Today there are thousands of wireless hotspots worldwide. Together, we are working to make the wireless experience as common as, let's say, a cup of coffee.

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25 companies to watch

BY PAUL BOUTIN

As the Wi-Fi industry evolves from a handful of hot spots into a full network, it is splitting into four sectors: service providers that operate networks; software firms whose apps tweak the usefulness of Wi-Fi or manage networks; hardware that connects you to the network; and chipsets at the core of the hardware.

SERVICE PROVIDERS

Independent Wi-Fi providers, like early ISPs, face competition and consolidation as telecom firms enter the fray. Cellular carriers and Baby Bells have mostly avoided the scene: Compared with cell phone systems, Wi-Fi suffers from limited range and a puny market. It makes sense for the big boys to wait until smaller providers grow the market, then swoop in and take over. It won't happen this year, or next, but it's coming.

COMPANY	CEO	OWNERSHIP	PARTNERS	SERVICE	WIRED OUTLOOK
AT&T WIRELESS SERVICES Redmond, Washington	John Zeglis	NYSE: AWE	Wayport	Cellular, corporate wireless, Wi-Fi data	AT&T's still-growing wireless division isn't waiting around for Cometa. Instead, it's pushing its own GoPort service at airports and hotels. But availability is still limited to five airports and a few hundred hotels.
BOINGO WIRELESS Santa Monica, California	Sky Dayton	Private	Airpath, NetNearU, Surf and Sip, Wayport	National Wi-Fi network	Dayton's strategy worked for EarthLink: Let others set up the networks, then place a single brand name and billing system atop them. But investor Sprint PCS may want in name or the market.
COMETA NETWORKS San Francisco, California	Lawrence Brilliant	Private	AT&T, IBM, Intel	Wholesale national Wi-Fi network	This high-profile venture aims to build the infrastructure for mainstream Wi-Fi services. If it works, everyone will benefit, from consumers to other tech firms.
IPASS Redwood Shores, California	Ken Denman	Private; has filed for IPO	Cometa, Wayport	Remote access	Wi-Fi is just part of the roaming access package iPass provides to business road warriors. By ignoring the consumer market, it has established enough market share to compete against telecom firms looking to offer Wi-Fi.
SURF AND SIP San Francisco, California	Rick Ehrlinspiel	Private	Boingo	National Wi-Fi network	The best, but probably the last, of the independents. This five-person firm operates 350-plus hot spots in small businesses in the US and UK, but much bigger players will soon be courting its customers.
T-MOBILE USA Bellevue, Washington	No CEO. John Stanton, board chair; Robert Dotson, president and COO	T-Mobile International, a subsidiary of Deutsche Telekom AG; NYSE: DT	Starbucks	Cellular, Wi-Fi network	Formerly VoiceStream, the American arm of DT operates networks at more than 2,100 Starbucks. This high-visibility service places T-Mobile ahead of the competition.
WAYPORT Austin, Texas	Dave Vucina	Private	AT&T Wireless, Dell, Intel, iPass	High-speed fixed line and wireless Net access in hotels and airports	Wayport operates hundreds of hot spots in prime locations like Sea-Tac airport and the Four Seasons. But how will it fare against lurking wireless giants?

SOFTWARE COMPANIES

Wi-Fi is attracting a wave of software innovators whose wares could disrupt the market by letting home and business networkers do without big-ticket hardware or service contracts.

COMPANY	CEO	OWNERSHIP	PRODUCT	WIRED OUTLOOK
MESHNETWORKS Maitland, Florida	Richard Licursi	Private	Software to extend wireless LANs	MeshNetworks' software lets wireless laptops double as base stations for others, extending a network's reach. This is a disruptive technology, which could provide a radical alternative to long-range cell phone networks.
PRONTO NETWORKS Pleasanton, California	Jasbir Singh	Private	Hot spot management software	Backed by $9 million from Intel and DFJ, the company's wireless ISP management and billing software is becoming the choice of midsize players positioning for easy buyout in the coming consolidation.
TELESYM Bellevue, Washington	Raju Gulabani	Private	Voice-over-IP software	Intel's investment raises the likelihood the company's wares will be bundled with laptops and PDAs as a cell phone alternative. Biggest threat: Microsoft could add a similar app to Windows.
TREPIA Fremont, California	Jawed Karim	Private	Software that creates a buddy list of other wireless users nearby	A great application (why doesn't my phone do that?), but like AIM or Napster, it will need big investment dollars to reach a critical mass of partners. Acquisition by a major service provider seems likely.

XPLANE

HARDWARE MAKERS

This sector will soon be a battle between scrappy gear makers and entrenched equipment makers. First-mover companies include those that manufacture or resell base stations, client cards, and Wi-Fi-ready devices. Look for notebook leaders like Dell to also offer client cards and quietly steal the market. Still, with so many laptops and desktop PCs already in use, demand for base stations and clients will only go up.

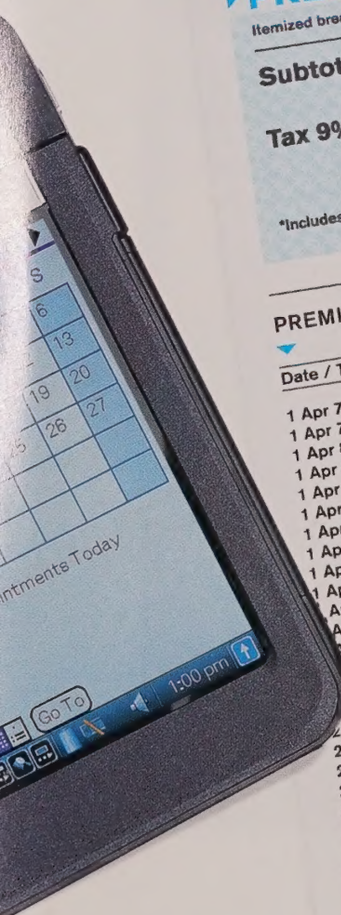
COMPANY	CEO	OWNERSHIP	PARTNERS	WIRED OUTLOOK
APPLE COMPUTER Cupertino, California	Steve Jobs	Nasdaq: AAPL	N/A	By renaming it AirPort and hiding the antennas, Apple made 802.11b a household word. But PC makers have since caught up, and they're competing on price.
CISCO SYSTEMS San Jose, California	John Chambers	Nasdaq: CSCO	Atheros, Intel, HP	The network hardware colossus recently began providing free security and range-extending software to makers of most Wi-Fi chipsets, ensuring demand for its access points and other backend equipment.
DELL COMPUTER Round Rock, Texas	Michael Dell	Nasdaq: DELL	N/A	Michael Dell has sent a message to the market: Dude, you're getting Wi-Fi. Built-in Intel chipsets on all notebooks could undermine the premium positioning of add-on cards.
D-LINK Taipei, Taiwan	Ken Kao	TWSE: 2332.tw	N/A	D-Link or Linksys? It's a common question. The company's challenge is to differentiate its products.
LINKSYS GROUP Irvine, California	Victor Tsao	Private	Net2Phone	The Honda of hardware: fast-growing, cheap, utilitarian. New products to extend existing networks add extra sales per customer.
MICROSOFT Redmond, Washington	Steven Ballmer	Nasdaq: MSFT	Intersil	Software makers, stay home: Wi-Fi is the next thing to be absorbed into Windows. The company already resells base stations and other hardware that feature user-friendly encryption.
NETGEAR Santa Clara, California	Patrick Lo	Private	Net2Phone, Philips	Rival to Linksys and D-Link, Netgear is the third name in do-it-yourself networking's Big Three. The company's formula is simple: Make good stuff cheap. Private status may prove an advantage if tech stocks keep falling.
PROXIM CORPORATION Sunnyvale, California	Jonathan Zakin	Nasdaq: PROX	Avaya, Digital China Holdings, Motorola	The acquisition of Lucent's Agere spinoff, along with its popular Orinoco cards, consolidated Proxim's brand strength but added to last year's $240 million loss.
VIVATO San Francisco, California	Ken Biba	Private	N/A	This new kid on the block has a smart antenna that reaches out to find users hundreds of feet away. If it works, it could become standard for big installations.

CHIPSET MANUFACTURERS

Wi-Fi is one of a few bright spots in the moribund semiconductor industry. The companies that build the radio hardware to go into other firms' base stations, access cards, and computers are supplying the wireless equivalent of a cable jack. However, this demand is already spurring consolidation. Watch as giant chipmakers like Intel integrate 802.11 circuits onto motherboards, removing the need for a separate wireless chipset.

COMPANY	CEO	OWNERSHIP	CUSTOMERS	WIRED OUTLOOK
ATHEROS COMMUNICATIONS Sunnyvale, California	Rick Redelfs	Private	D-Link, HP, Linksys, Netgear, Philips, Proxim, SMC, Sony	Four of the top five notebook sellers build in Atheros' dual-band 802.11a/b chipset, and the company is at work on a new product that will also meet demand for the emerging 802.11g standard.
BROADCOM CORPORATION Irvine, California	Alan Ross (interim)	Nasdaq: BRCM	Cisco, Dell, HP, IBM, Motorola	Broadcom's 54g chipset is poised for success, even before 802.11g is final. Linksys, Belkin, AMD, and others have pledged to use or support it.
INTEL Santa Clara, California	Craig Barrett	Nasdaq: INTC	Dell, HP, Sony	Intel is the 800-megaton gorilla in this market. Makers of dedicated Wi-Fi chipsets stand to lose big as the company incorporates Wi-Fi into its motherboard components.
INTERSIL CORPORATION Milpitas, California	Rich Beyer	Nasdaq: ISIL	Cisco, IBM, Nokia, Sony	Intersil's Prism2 is pretty much the industry standard. The company's only real threat is a big one: Intel and other CPU makers want to eliminate the need for a separate Wi-Fi chipset.
TEXAS INSTRUMENTS Dallas, Texas	Thomas Engibous	NYSE: TXN	D-Link, US Robotics	TI's proposal for 802.11g was rejected, setting back plans to dominate next-gen wireless networking chipsets.

fast forward



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Deluxe Voice Service (includes satellite and landline)	39.99
Mobile Email	5.99
Mobile Internet Connectivity	5.99
Television Entertainment Package	49.99
Home Alarm System (with invisible fence option)	29.99
Monthly Airtime Charges Subtotal	131.94

PREMIUM SERVICES CHARGES

Itemized breakdown on pages 2-11.

Subtotal	1,445.34
Tax 9%	141.96
TOTAL	1,719.24

*Includes use of two multifunction LG Siemens handsets

PREMIUM SERVICES

Date / Time	Location	Activity	Pricing Plan	Charge
1 Apr 7:32	Home	Key retrieval	Tier 1	0.00
1 Apr 7:38	Deerfield, IL	Traffic dwnld	Tier 1	0.00
1 Apr 8:13	Edens Expwy	Toll	External	9.00
1 Apr 8:15	Skokie, IL	Traffic dwnld	Tier 1	0.00
1 Apr 8:16	Edens Expwy	Music dwnld: Eminem: Greatest Hits	Tier 2	9.99
1 Apr 8:36	Chicago, IL	Traffic zone fee	External	8.00
1 Apr 9:08	Chicago, IL	Parking	External	6.00
1 Apr 9:35	Chicago, IL	Horoscope dwnld	Tier 2	3.00
1 Apr 15:47	Chicago, IL	Conferencing services/4 parties	Tier 3	30.00
1 Apr 18:34	Edens Expwy	Traffic dwnld	Tier 1	0.00
Apr 19:00	Northbrook, IL	Toll	External	14.00
Apr 19:01	Home	Video dwnld: Fox News	Tier 2	4.50
Apr 20:30	Home	Ebook dwnld: Infinite Jest Chap 250-500	Tier 2	3.20
Apr 21:02	Home	Ebook dwnld: Infinite Jest Chap 501-750	Tier 2	3.20
Apr 22:23	Home	Film dwnld: The Remains of the Day	Tier 2	12.00
Apr 23:00	Deerfield, IL	Premier dwnld: WWE Royal Rumble 2006	Tier 2	100.00
Apr 6:45	Kennedy Expwy	Traffic dwnld	Tier 2	0.00
2 Apr 6:57	ORD Airport	Toll	Tier 3	7.00
2 Apr 7:33	ORD Airport	Parking fee: 1 day	Tier 1	23.00
2 Apr 7:59	ORD Airport	Vending machine: 6 oz Red Bull AM	External	2.10
2 Apr 8:03	American United	Game dwnld: Vice City IV	External	5.00
2 Apr 8:45	American United	In-flight Wi-Fi	External	20.00
2 Apr 11:32		Misc: salted peanuts	Tier 2	3.00
			Tier 2	
			External	

PG. 2/13

PG. 3/13

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